FIBER POST BIBLIOGRAPHY

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I. Post Fit and Shape

*Ananviriyaporn, S. Salimee, P, **Fiber Post Sizes Effect on Fracture Resistance of RCT Teeth.** . *J Dent Res. Vol 87 (Spec. Iss. C) Abstract #0131, 2008(www.dentalresearch.org)*

Objective: To study the fracture resistance of RCT teeth restored with different diameters and lengths of fiber posts. **Material and method**: Thirty maxillary central incisors were divided into 3 groups. After RCT-treated, spaces for post were prepared 8 mm. deep with drill of post #2. All groups were restored with fiber post (D.T. light-post). The first group used the size that properly fit the canal (post #2). The second group used the post with the same canal length but smaller diameter (post #1). The third group used the post that bigger diameter than the canal (post #3), inserted into canal untilled fit the cervical part of the canal that the length was considered to be 4 mm. resulted the post shorter than the canal length. After cementing with resin cement (Panavia F 2.0), a core build-up with composite was performed, the teeth were embedded in self cure acrylic resin block. The samples were loaded on a universal testing machine with a crosshead speed of 2 mm/min on the palatal surfaces at 90o angles to the long axis of the tooth until failure occurred. **Result:** Fracture resistance of group 1, group 2 and group 3 were 108.33± 11.59 N, 79.08± 12.15 N and 94.87± 14.48 N, respectively. ANOVA and Bonferroni test revealed that there was no significant difference of the fracture resistance between group 1 and group 3 ($p<0.05$). But group 2 was significantly different from the other groups ($P<0.05$). No root fractures occurred in any of the experimental groups. **Conclusion:** RCT teeth restored with fiber post that the diameter properly fit the cervical part of canal were significantly stronger than those restored with the entire length of post but diameter was not fit the canal.

*Baldissara, P., Zicari, F., Ciocca, L., Zamboni, S. C. ,Valandro, L. F. **Effect of fiber post emerging diameter on composite core stabilization.** *.J Dent Res. Vol 86 (Spec. Iss. A) Abstract #2623, 2007 (www.dentalresearch.org)*

Objectives: The relatively low elastic modulus of fiber posts reduce the risk of root fracture, but also decrease the composite core stabilization. To compensate for the lack of rigidity, larger post sizes are needed when restoring crownless teeth. The aim of this study was to evaluate the effect of the post emerging diameter on the composite core stabilization of restored flat root human teeth. **Methods:** Forty single rooted, crownless human teeth were divided in 8 groups and randomly restored with quartz (Endolightpost and DT Light - Post, RTD, St Egreve, France) and glass (Premier Anatomic and Compaq, Innotech, Italy) fiber posts, each type represented with #1 and #2 sizes. Single tapered and double tapered post shapes were used. The posts were inserted 10mm deep in the root canal and cemented using Duo-Link and One-Step adhesive (Bisco, USA). The emerging diameter ranged from 1.00 to 1.50mm. The core was realized using Light-Core (Bisco) placed in transparent standardized shells. The specimens were stored in 100% humidity until the Instron loading tests, carried out at a 45° angle. The force required to detach the core from the dentin flat surface was considered as the fracture strength (FS). Data obtained were statistically analyzed with ANOVA and linear regression. **Results**: FSs ranged from 264±95N (Endolightpost #1) to 425.1 +/- 55N (DT Light-Post #2: RTD; St Egreve, France) ($P<0.05$). Single tapered posts were weaker than double tapered ones. FS was directly correlated to post emerging diameter ($P=0.017$). Notwithstanding the loss of dentin required to place larger posts, the root fracture rate was not significantly correlated to the post diameter ($P=0.8$). **Conclusion:** The emerging diameter of fiber post is extremely important to stabilize the core. When restoring crownless teeth, it is advisable to use fiber posts having large emerging diameters. Data obtained suggest that diameters of 1.5mm do not jeopardize the root dependability.

*Baldissara, P., Filonzi, C., Zicari, F., Ciocca, L. **Establishing an improved fiber post shape using a 3-D analysis.** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #0535, 2005. (www.dentalresearch.org)*

Objectives: When restoring endodontically treated teeth with fiber post, the coronal third of the root canal is often much more larger than both medium and apical portion. Fiber posts are frequently too small in diameter at this level, particularly in teeth previously treated, and a large amount of cement is required to fill the post/dentin gap. The aim of this study was to determine the root canal shape immediately prior the post space preparation, to obtain data for an improved post design**. Methods**: After guttapercha removal, 40 poly-vinyl polysiloxane impressions of the root canal of endodontically treated teeth scheduled for fiber post restorations were taken by a single operator. Molars and lower incisors were excluded. Stone casts were obtained from the impressions. The casts were progressively grinded, taking a standardized microphotograph every 1mm. The canal length and both buccolingual and mesio-distal diameters were measured, obtaining a mean computer-designed 3-D canal profile. The canal shapes were compared to different fiber posts using graphics software. **Results:** the coronal and central thirds of the incisors, canines and 2nd bicuspids were found significantly larger than standard fiber posts. In these teeth, DT Light-Post (RTD, St Egreve, France) showed the best fit (although not ideal) when compared to single tapered or parallel sided posts. The mean canal length was 8.9„b1.4mm. When graphically superimposed on the 3-D images, extremely good adaptation was found with a post having a tapered root portion of 6¢X, 12mm in length, and parallel-sided coronal head 5mm in length. The head diameters should vary from 1.8 to 2.4mm to match the different tooth sizes. **Conclusions:** The canals of endodontically treated teeth are larger than available fiber posts, particularly at the coronal segment. An increased tapering and a larger coronal diameter have been introduced in a new post design obtaining a better post/dentin adaptation.

*Boudrias, P, Sakkal, S, Yulian, **Anatomical post design applied to quartz fiber/epoxy technology: A conservative approach**. *Oral Health, Nov., 2001:9-16*

Abstract/conclusions: A wide variety of prefabricated posts systems are manufactured with different materials and offered with different shapes. Post and core adaptation presents an important element in the biomechanical performance of the prosthetic restoration. The double taper post system was designed with the purpose of providing close canal adaptation with minimal tooth structure removal. The association of a quartz fiber/epoxy material with a more anatomical double taper shape provides a conservative and esthetic approach for the restoration of endodontically-treated teeth. The double taper post (D.T. Light-Post; RTD, St Egreve, France/Bisco Dental) allows one to rebuild the missing tooth structure using adhesive technology without obstructing the esthetics of the all-ceramic restorative systems. The double taper post closely imitates the post-endodontic shape of a radicular canal, and leaves a thin and uniform thickness of cement at the post/canal interface. This improved adaptation of the post promotes the mechanical properties of the quartz fiber/epoxy material, instead of the weaker composite resin cement. In as much as in vitro and early clinical follow-up are encouraging, long-term clinical study is needed to evaluate the behavior of this post system and the prosthetic prognosis of teeth with extensive coronal destruction. **PDF**

*Boudrias, P., Sakkal, S., and Petrova, Y. **Anatomical post design meets quartz fiber technology: Rationale and case report**. *Compendium. 22: 337-348, 2001.*

Abstract/conclusions: Endodontically treated teeth frequently require a post and core to serve as a foundation for the coronal restoration. Remaining tooth structure, physical properties of the post material, post shape, and cement type all contribute to the success of the restoration. Post adaptation to the canal walls also represents an important element in the biomechanical performance of the prosthetic restoration. A double taper post system made of quartz fiber and epoxy was developed to conform more precisely to the shape of endodontically treated canals. Immediate benefits of this post system include minimal tooth structure removal during canal reshaping, greater post-to-canal adaptation in the apical and coronal half of the canal, and good post retention. The use of a quartz fiber/epoxy material with a lower modulus of elasticity also reduces the incidence of root fracture. Furthermore, the esthetic nature of the colors offered with this post system (D.T. Light-Post; RTD, St Egreve, France) provide a favorable foundation for eliminating discoloration caused by a metallic post placed under all-ceramic crown systems. **PDF**

Coniglio, I., et al.**. Post space debridement in oval-shaped canals: the use of a new ultrasonic tip with oval section top of form.** Journal of Endodontics Volume 34, Issue 6 , Pages 752-755, June 2008

This study evaluates the effect on post space debridement in oval-shaped canals of an experimental ultrasonic tip with oval section (Satelec) compared with a circular ultrasonic tip (KaVo). Thirty teeth with an oval-shaped canal were endodontically treated and obturated and then randomly divided into 3 groups (n = 10) according to the procedure used for post space debridement: Satelec tip, Largo #2 drill + KaVo file, and Largo #2 drill + water. Debris and dentin tubules were evaluated by assigning scores to scanning electron microscope post spaces images; lower scores corresponded to fewer debris and higher number of open tubules. The Satelec group showed significantly lower debris and open tubules scores than KaVo group ($p < .05$) and control group ($p < .05$), which differed significantly between each other ($p < .05$). Also the debris and open tubules scores in different post space regions differed significantly among the experimental groups ($p < .001$). The oval ultrasonic tip resulted in a better post space debridement than a circular ultrasonic tip in oval-shaped canals.

Dietschi, D., Romelli, M., and Goretti, A. **Adaptation of adhesive posts and cores to dentin after fatigue testing.** *International Journal of Prosthodontics. 10: 498-507, 1997.*

Abstract/conclusions: An in vitro nondestructive fatigue test was applied to adhesive posts and cores made on endodontically treated human teeth. Five post-and-core systems were evaluated: one Zirconia oxide post, two Titanium posts (with resinous or ceramic coating), and two resin-fiber posts. Each test specimen was intermittenly loaded and thermocycled. The scanning electron microscope observation of sample sections showed that only the interfaces between restorative materials and dentin exhibited substantial deficiencies. The Komet ER (Brasseler) exhibited the greatest percentages of continuity at the coronal (83.88%) or the radicular (78.12%) dentin levels, while the Zircon experimental post presented insufficient adaptation to the radicular 21.25% continuity) and to the coronal (53.25% continuity) dentin. Seven of eight samples in the Komet group showed root fractures. The carbon-fiber post (Composipost) behaved satisfactorily (67.38% radicular continuity), in spite of the use of an older bonding agent formulation. **PDF**

*Medioni, E., Griva, J. **Fiber post adaptation when using root canal shaping NiTi files** *J Dent Res. Vol 87 (Spec. Iss. A) Abstract #1503, 2008. (www.dentalresearch.org)*

One of the most difficult steps when restoring endodontic treated teeth is the post space preparation: a bad post space preparation can occur and induce irreversible damage to the tooth. **Objectives:** evaluation of adaptation of two different fibre posts after shaping the root canal by two different NiTi rotary files.**M ethods**: 40 healthy teeth, freshly extracted were selected. Twenty root canals were shaped using RaCe System (FKG, La Chaud de Fond, Switzerland) and twenty using Protaper system (Dentsply-Maillefer, Ballaigues, Switzerland). PeerlessPost System (Sybron Endo, USA) and D.T. Light-Post system (VDW Dentsply/ RTD, St Egreve, France) were fixed into the root canal using an impression paste, without post space preparation. After embedding roots

into an epoxy resin and longitudinal cutting, the adaptation of posts was assessed by measuring the length of penetration and the thickness of "sealer". Statistical analyses to compare post adaptation were made using non parametric tests. **Results:** Regarding the length of post penetration, there is a statistical significant difference between the different posts when different root canal shaping instruments are used (p=0,013). When using RaCe rotary files, penetration length of Peerless posts is greater than with DT posts. There is no statistical significant difference for the thickness "sealer" at the tip (p=0,972) and at 3mm from the tip of the post (p=0,2344), but at the ECJ, there is a statistical significant difference (p=0,011). The "sealer" is less thick (p=0,0073) with Peerless Posts than with DT posts when root canal is shaped by Protaper system, and thicker (p=0,0008), when using Peerless posts comparing RaCe shaping and Protaper shaping. **Conclusion**: In the conditions of this experimentation, the post space preparation with specific drills is not necessary if root canal shaping is preformed with RaCe or Protaper NiTi rotary files and when Peerless posts or D.T. Posts are used

Wandscher V, Bergoli C, Limberger I, Ardenghi T, Valandro L. **Preliminary results of the survival and fracture load of roots restored with intra-canal posts: Weakened vs Non-weakened Roots.** *Oper Dent. 2014 Feb 6. [Epub ahead of print]*

Purpose: To evaluate the fracture load and survival rate of weakened and non-weakened roots restored with different intra-canal posts. **Methods:** Eighty teeth (16 mm) were prepared to a length of 10 mm with a custom drill. Fifty roots were weakened with a tapered diamond drill, and 30 roots were not. The specimens were embedded with acrylic resin up to 3 mm from the coronal aspect, and the periodontal ligament was simulated. The 50 weakened roots were restored with (n=10) CPC-gold (cast post and core made of gold alloy), CPC-Ni (cast post and core made of Ni-Cr alloy), FP (glass fiber posts), FP-W (glass fiber posts with a wider coronal diameter), and FP-CR (fiber posts relined with composite resin). The 30 non-weakened roots were restored with (n=10) CPC-gold, CPC-Ni, and FP. All of the posts were adhesively cemented. All of the specimens were mechanically cycled (37°C, 45°, 130 N, 2.2 Hz, and 1.5 million pulses) and evaluated after every 5 × 104 cycles to evaluate the presence of cracks as a primary outcome (event). The specimens that survived cycling were subjected to a fracture load test (load application on the palatal aspect at a 45° inclination). Failure mode was classified as favorable (above the simulated bone level) and catastrophic (below the simulated bone level). Survival rates were estimated using the Kaplan-Meier method. Fracture load data were analyzed using the Kruskal-Wallis test (α=0.05) for weakened roots, one-way analysis of variance, and Tukey test ($p<0.05$) for non-weakened roots, and Student t-test ($p<0.05$) compared non-weakened vs weakened roots for the same post system. **Results:** For the preliminary survival results, FP-W showed a higher survival rate when compared with CPC (gold/Ni). For the fracture load (N), the statistical analysis ($p<0.0001$) presented differences among the weakened groups: CPC-gold (541.4) = CPC-Ni (642.6) > FP (282.2) = FP-W (274.1) = FP-RC (216.6). No differences were observed for the groups that were non-weakened (majority of favorable failures): CPC-gold (459.3) = CPC-Ni (422.0) = FP (347.9). Weakened roots restored with CPC-gold promoted high values of load fracture and unfavorable failure rates. **Conclusion:** Cast post and cores or fiber posts can be used for restoring non-weakened roots. However, for weakened roots, a fiber post with a wider cervical emerging diameter appears to be a better alternative when compared with cast post and cores.

II. Physical Properties; the posts by themselves

A. FLEXURAL STRENGTH

*Barceleiro, M., Soares, L.P., Poiate, I., Portero, P.P., Vasconcellos, A.B., Teixeira, C.A **Influence of autoclave sterilization on flexural strength of fiberglass posts**. *J Dent Res.Vol 92 (Spec Iss A) Abstract #3130, 2013 (www.dentalresearch.org)*

Objectives: The sterilization of fiber-reinforced resin posts may be necessary if during adaptation tests, they are changed by other with different diameter. The sterilization in autoclave, however, may generate some kind of structural change that may prejudice their mechanical properties and clinical performance. The aim of this study was to evaluate the influence of sterilization method on the physical structure of reinforced fiberglass posts (FRC Postec - Ivoclar and Transluma - Bisco) or fiber quartz posts (DT Light Post – Bisco/ RTD, St Egreve France) after 1 or 2 cycles of sterilization. **Methods:** Eight posts of each brand, divided into 3 groups (FRC, TRL and DT), were subdivided into three subgroups, according to the number of sterilization cycles: a subgroup with no sterilization (control), one with one sterilization (Subgroup 2) and Subgroup 3 with 2 sterilization cycles. After sterilization procedures, the posts were submitted to three-pointing bending test (ASTM D2344). **Results:** The main values of maximum force required to fracture the pin in different groups were: DT1 (202 ± 8.39 N), DT2 (190.2 ± 10.02 N), DT3 (177.9 ± 14.75 N); FRC1 (152.6 ± 27.19 N); FRC2 (130.9 ± 25.99 N); FRC3 (128.1 ± 18.41 N); TRL1 (143.5 ± 6.15 N); TRL2 (144 ± 8.62 N); TRL3 (134 ± 6.51 N). The results treated by ANOVA and SNK ($p \leq 0.05$) showed significant differences within the groups DT (1 = 2> 3) and TRL (1 = 2> 3). **Conclusions:** It was concluded that the posts tested can be sterilized by an autoclave cycle with no loss in flexural strength. The FRC Postec Post can be sterilized by two cycles without mechanical damage.

*Beck, P., Ghuman, T., Cakir, D. Ramp, L. Burgess, J. **Evaluation of flexural strength and elastic modulus of endodontic posts.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 3065, 2009. (www.dentalresearch.org)*

Post fracture is a frequently reported failure for restored endodontically treated teeth. Current reports suggest that the rigidity of the post should be equal or close to that of the tooth structure in order to distribute the occlusal forces along the length of the root.

Objective: To determine and compare modulus of elasticity and flexural strength of endodontic posts. **Methods:** Five fiber posts (Unicore/Ultradent, DT Light-Post/Bisco/RTD St Egreve, France, RelyX/3M ESPE, Snowlight/Danville, Parapost Fibre White/Coltene Whaledent) and 1 metal post (Parapost XT/Coltene/Whaledent) were used for this study (n=10). They were measured for length and diameter and placed on a 3- point bending test fixture. The posts were loaded in a universal testing device, (Instron, Model 5565) using flexural test method until failure having a 1 mm/min crosshead speed. The fracture data was compared using a one-way ANOVA and Tukey post-hoc tests to examine for intergroup differences (p=0.05). Two samples were randomly selected from each group and evaluated using a scanning electron microscope (SEM) to determine the adaptation & orientation of the glass fibers. **Results:** Flexural strength results are displayed in (MPa±SD) and modulus of elasticity results are displayed in (GPa±SD)

	UNICORE	DT LIGHT-POST	RelyX	ICE LIGHT	PARAPOST FIBRE WHITE	PARAPOST XT
Flexural	1305.9±81	1191.6±157	1133.1±67	1234.3±300	1077.5±172	1897.9±151
E-Modulus	30.4±3	32.1±2	26.4±3	31.8±10	34.3±8	60.9±7

Unicore fiber post had significantly ($p<0.05$) higher flexural strength compared to the Parapost Fibre White post. Parapost XT titanium alloy post had a significantly higher flexural strength and modulus ($p<0.05$) compared to the fiber posts. **Conclusion:** Posts should be selected in part for their mechanical properties. Supported in part by a grant from Ultradent.

Cheleux, N., Sharrock, P.J., **Mechanical properties of glass fiber-reinforced endodontic posts.** *Acta Biomater. 2009 Oct;5(8):3224-30. Epub 2009 Apr* 24.

Five types of posts from three different manufacturers (RTD, France, Carbotech, France and Ivoclar-Vivadent, Liechenstein) were subjected to three-point bending tests in order to obtain fatigue results, flexural strength and modulus. Transverse and longitudinal polished sections were examined by scanning electron microscopy and evaluated by computer-assisted image analysis. Physical parameters, including volume % of fibers, their dispersion index and coordination number, were calculated and correlated with mechanical properties. The weaker posts showed more fiber dispersion, higher resin contents, larger numbers of visible defects and reduced fatigue resistance. The flexural strength was inversely correlated with fiber diameter and the flexural modulus was weakly related to coordination number, volume % of fibers and dispersion index. The interfacial adhesion between the silica fibers and the resin matrix was observed to be of paramount importance. **PDF**

Chieruzzi, M, Pagano, S, Pennacchi, M, Lombardo, G, D'Errico, P, Kenny, JM**. Compressive and flexural behaviour of fibre reinforced endodontic posts.** ***J*** *Dent. 2012 Nov;40(11):968-78. doi: 10.1016/j.jdent.2012.08.003. Epub 2012 Aug 21.*

Objectives: The aim of this study was to investigate the mechanical properties of five types of fibre-reinforced composite (FRC) posts and compare them with traditional metal post. **Methods:** Five FRC posts and a metallic post having different geometry and type of fibre (glass, carbon or quartz fibre) were loaded to failure in compression and bending. The transverse sections of FRC posts were observed using SEM to evaluate the fracture mode and the percentage of fibres (compared with burn-off test). Densities and voids content were also evaluated. **Results:** Mechanical results were subjected to a one-way ANOVA and Tukey test ($p<0.05$). In compression, quartz fibre posts (Light-Post; RTD; St Egreve, France) exhibited the greater maximum load and ultimate strength, carbon fibre posts showed a poor compressive behaviour. All posts had similar compressive moduli. Carbon posts showed the highest flexural properties ($p<0.0001$) while glass posts the greater maximum load. The fracture load values correlated to the diameters of posts showed a parabolic behaviour. The flexural strengths of all posts were four and seven times higher than dentine. The elastic moduli of almost all posts were similar to dentine. The compressive strengths were lower than flexural strengths. The fibre diameters ranged from 5.2 to 26 μm, the volume percentage of fibres was about 64%. The content of voids of some posts lower their mechanical behaviour. **Conclusions:** Compressive properties of FRC posts were lower than in bending. The flexural properties of FRC posts were higher than the metal post and similar to dentine. The mechanical behaviour is influenced by voids. **PDF**

*Galhano, GA, Valandro, LP, deMelo, R., Scotti, R., Bottino, MA. **Evaluation of the flexural strength of carbon fiber, quartz fiber and glass fiber – based posts.** *JOE Vol. 31. No. 3, March 2005, 209-211*

This study investigated the flexural strength of 8 fiber posts (one carbon fiber, one carbon/quartz fiber, one opaque quartz fiber, two translucent quartz fiber and three glass fiber posts). Eighty fiber posts were used and divided into 8 groups (n=10): G1- Composipost / C-Post (RTD), G2-Aestheti-Post (RTD), G3-Aestheti-Plus (RTD), G4- Light-Post (RTD), G5- D. T. Light-Post (RTD), G6- ParaPost White (Coltene/Whaledent), G7-FibreKor (Pentron) and G8-Reforpost (Angelus). All of the samples were tested using a three-point bending test. Statistical analysis of the outcomes was conducted by means of analysis of variance and the post

factor was significant (p<0.001). The critical value for comparison revealed that G2 (677.4 MPa +/18.3) and G3 (666.2 +/- 18.1) presented the highest flexural strength values. G1 (616.3 +/- 24.8) and G3 presented similar strengths. G1, G4 (607.2 +/- 19.5), G5 (608.7 +/-69.5), G6 (585.2 +/- 24.2) and G7 (562 +/- 59.6) were statistically similar. Reforpost-G8 (433.8 +/- 46.4) revealed the lowest flexural strength value compared to the other groups. **PDF**

*Khatter, R, Singh, RD., Sroa, R. Rigidity, **retention, and resistance of titanium versus double taper light root canal posts: An in vitro evaluation**. *Indian J Dent Res [serial online] 2011 [cited 2013 Jan 27];22:879.*

Aim: to evaluate and compare the physical properties of titanium posts and double taper DT Light-Posts. **Methods:** Sixty posts (30 titanium post and 30 DT Light- Post, RTD; St Egreve, France) were selected and divided into three groups. In Group I: Ten posts of each type were subjected to a three-point bending test. In Group II: 20 posts extracted maxillary central incisors were restored with ten posts of each type and subjected to tensile loading. In Group III: 20 posts extracted maxillary central incisors were restored with ten posts of each type and subjected to compressive loading at an angle of 135°. **Results:** The results showed that DT Light-Posts were significantly less rigid (P <0.001), more retentive and significantly less resistant to fracture (P <0.001) as compared to titanium posts. **Conclusion**: It is suggested that although the DT Light-Post system does not completely fulfill the requirements claimed by manufacturer but it would meet the requirements to combat the physiological forces operating in the oral cavity.

Novais, V.R., Quagliatto, P.S., Bona, A.D., Correr-Sobrinho, L, Soares, C.J.. **Flexural modulus, flexural strength, and stiffness of fiber-reinforced posts.** *Indian J Dent Res. 2009 Jul-Sep;20(3):277-81.*

Background: The radiopacity degree of posts is not enough for adequate visualization during radiographic analyses. Glass fiber post with stainless steel reinforcement has been fabricated in an attempt to overcome this limitation. AIM: This study was designed to determine the influence of this metal reinforcement on the post mechanical properties. **Methods:** This study evaluated flexural modulus (E), flexural strength (sigma), and stiffness (S) of five different fiber post systems (n = 5): RfX (Reforpost Glass Fiber RX; Angelus, Londrina, PR, Brazil); RG (Reforpost Glass Fiber, Angelus); RC (Reforpost Carbon Fiber, Angelus); FP (Fibrekor Post; Jeneric Pentron Inc., Wallingford, CT, USA); and CP (C-Post; Bisco Dental Products, Schaumburg, IL, USA), testing the hypothesis that the insertion of a metal reinforcement (RfX) jeopardizes the mechanical properties of a glass fiber post. Posts were loaded in three-point bending using a testing machine with a crosshead speed of 0.5 mm/min. **Results:** The results were statistically analyzed using one-way ANOVA and Tukey's multiple range tests (a = 0.05). Mean and standard deviation values of E (GPa), s (MPa), and S (N/mm) were as follows: RfX: 10.8 +/- 1.6, 598.0 +/- 52.0, 132.0 +/- 21.9; RG: 10.6 +/- 1.0, 562.0 +/- 24.9, 137.8 +/- 5.5; RC: 15.9 +/- 2.4, 680.5 +/- 34.8, 190.9 +/- 12.9; FP: 10.9 +/- 1.4, 586.8 +/- 21.9, 122.4 +/- 17.3; CP: 6.3 +/- 1.7, 678.1 +/- 54.2, 246.0 +/- 41.7. Carbon fiber posts showed the highest mean s values (P < 0.05). In addition, RC showed the highest mean E value and CP showed the highest mean S value (P < 0.05). **Conclusion:** The hypothesis was rejected since the metal reinforcement in the glass fiber post (RfX) does not decrease the mechanical property values. Posts reinforced with carbon fibers have a higher flexural strength than glass fiber posts, although all posts showed similar mechanical property values with dentin. **PDF**

Novais, VR, Versluis, A, Correr-Sobrinho, L, Soares, CJ. **Three-point bending testing of fibre posts: critical analysis by finite element analysis.** *International Endodontic Journal Article first published online: 28 JAN 2011 DOI: 10.1111/j.1365-2591.2011.01856.x*

Aim: To evaluate the effect of taper, specimen supports and the isotropic and orthotropic properties of the posts on flexure and stress response during three-point bending using finite element analysis. **Methodology:** A three-dimensional finite element model of a fibre post was created. The occlusal portion was cylindrical whilst the apical portion was tapered. Five different support positions were evaluated during a simulated three-point bending test: M1 – support distance of 10 mm centralized and no tilt; M2 – 10 mm centralized with tilt; M3 – 10 mm not centralized and no tilt; M4 – 10 mm not centralized with tilt; M5 – 6 mm not centralized with no tilt. A sixth post model (M6) was a centralized post without tapered section. The applied properties were elastic and orthotropic. **Results:** Tilting the tapered posts to level them in the test setup had little effect on the outcome. Flexure increased when 50% of the bent portion involved taper (M1, M2). If only 20% of the bent post involved taper (M3, M4), the flexure values were close to M6 (no taper). The orthotropic properties also caused increased flexure compared to an isotropic post. Maximum stresses were only a little higher when 50% of the bend structure involved taper, whilst the orthotropic properties had little effect. **Conclusions:** Regardless of levelling, the flexural stress determination with tapered fibre posts in the three-point bending test was valid as long as the tapered portion was limited in length.

Plotino, G, Grande, NM, Bedini, R, Pameijer, CH, Somma, F. **Flexural properties of endodontic posts and human root dentin**. *Dent Mater J. 2006 Vol 231129-1135*

Objectives: To evaluate the flexural modulus and flexural strength of different types of endodontic post in comparison with human root dentin. **Methods:** Three different types of fiber-reinforced composite (FRC) posts and three metal posts each comprising 10 specimens (n=10) and 20 dentin bars were loaded to failure in a three-point bending test to determine the flexural modulus

(GPa) and the flexural strength (MPa). Three randomly selected fiber posts of each group were evaluated using a scanning electron microscope (SEM) to illustrate the differences in mode of fracture. Data were subjected to a one-way ANOVA to determine significant differences between groups and the Bonferroni t-test multiple comparison was applied to investigate which mean values differed from one another with significance levels of P<0.05. **Results:** The flexural modulus recorded for the dentin bars was 17.5+/-3.8GPa. The values for posts ranged from 24.4+/-3.8GPa for silica fiber posts to 108.6+/-10.7GPa for stainless steel posts. The flexural strength for dentin was 212.9+/-41.9MPa, while the posts ranged from 879.1+/-66.2MPa for silica fiber posts to 1545.3+/-135.9MPa for cast gold posts. The ANOVA test analysis revealed significant differences between groups (P<0.05) for flexural modulus and flexural strength mean values. **Significance:** FRC posts have an elastic modulus that more closely approaches that of dentin while that for metal posts was much higher. The flexural strength of fiber and metal posts was respectively four and seven times higher than root dentin. **PDF**

*Seefeld, F, Wenz, HJ, Ludwig, K, Kern, M. **Resistance to fracture and structural characteristics of different fiber reinforced post systems.** *Dent Mater. 2007 Mar;23(3):265-71*

Results: The aim of this study was to investigate the ultrastructure and resistance to fracture of eight different types of fiber post, and to verify the existence of a correlation between structural characteristics and flexural strength. **Results:**: Eight types of fiber post were selected for this study. Fiber Kor (Jeneric-Pentron), Para Post Fiber White (Coltene), Luscent Anchor (Dentatus), Twin-Luscent Anchor (Dentatus), Style Post (Metalor), DT White-Post (VDW), DT Light-Post (VDW / RTD, St Egreve, France) and ER Dentin Post (Brasseler). Ten posts of each experimental group were selected for a three-point bending test, and one was processed for SEM evaluation. A universal testing machine loading at an angle of 90 degrees was employed for the three-point bending test. The test was carried out until fracturing of the post. After fracture testing, the posts with the highest and the lowest values of flexural strength of each system were additionally processed for SEM analysis. SEM evaluation was performed using a PC-measurement program to assess the fiber/matrix ratio and fiber dimensions. **Results:** The fracture load of the tested systems ranged from 60 to 96 N and the flexural strength from 565 to 898 MPa. DT White-Post and D.T. Light-Post (898 and 842 MPa, respectively) had significantly higher flexural strengths than the other posts. Style Post (565 MPa) showed a significantly lower flexural strength than all other posts. The differences in fiber diameter ranged from 8.2 to 21 micron and for the fiber/matrix ratio from 41 to 76%. Of the various structural characteristics investigated, only the fiber/matrix ratio showed a significant correlation to the flexural strength (r=0.922, p=0.003). **Significance:** The FRC-posts investigated displayed significant differences with regard to fracture load and flexural strength. A strong and significant linear correlation between the fiber/matrix ratio and the flexural strength was found. **PDF**

Sherfudhin, H, Hobeich, J, Carvalho, CA, Aboushelib, MN, Sadig, W, Salameh, Z. **Effect of different ferrule designs on the fracture resistance and failure pattern of endodontically treated teeth restored with fiber posts and all-ceramic crowns.** *J Appl Oral Sci. 2011 Jan-Feb;19(1):28-33.*

Objective: This study investigated the effect of different ferrule heights on endodontically treated premolars. **Methods:** Fifty sound mandibular first premolars were endodontically treated and then restored with 7-mm fiber post (FRC Postec Plus #1 Ivoclar-Vivadent) luted with self-polymerized resin cement (Multilink, Ivoclar Vivadent) while the coronal section was restored with hybrid composite core build-up material (Tetric Ceram, Ivoclar-Vivadent), which received all-ceramic crown. Different ferrule heights were investigated: 1-mm circumferential ferrule without post and core (group 1 used as control), a circumferential 1-mm ferrule (group 2), non-uniform ferrule 2-mm buccally and 1-mm lingually (group 3), non-uniform ferrule 3-mm buccally and 2-mm lingually (group 4), and finally no ferrule preparation (group 5). The fracture load and failure pattern of the tested groups were investigated by applying axial load to the ceramic crowns (n=10). Data were analyzed statistically by one-way ANOVA and Tukey's post-hoc test was used for pair-wise comparisons (α=0.05). **Results:** There were no significant differences among the failure load of all tested groups (P<0.780). The control group had the lowest fracture resistance (891.43 ± 202.22 N) and the highest catastrophic failure rate (P<0.05). Compared to the control group, the use of fiber post reduced the percentage of catastrophic failure while increasing the ferrule height did not influence the fracture resistance of the restored specimens. **Conclusions:** Within the limitations of this study, increasing the ferrule length did not influence the fracture resistance of endodontically treated teeth restored with glass ceramic crowns. Insertion of a fiber post could reduce the percentage of catastrophic failure of these restorations under function.

Stewardson, DA, Shortall, AC, Marquis, PM, Lumley, PJ. **The flexural properties of endodontic post materials.** *Dent Mater. 2010 Aug;26(8):730-6. Epub 2010 Apr 21*

Objectives: To measure the flexural strengths and moduli of endodontic post materials and to assess the effect on the calculated flexural properties of varying the diameter/length (D/L) ratio of three-point bend test samples. **Methods**: Three-point bend testing of samples of 2mm diameter metal and fiber-reinforced composite (FRC) rods was carried out and the mechanical properties calculated at support widths of 16 mm, 32 mm and 64 mm. Weibull analysis was performed on the strength data. **Results:** The flexural strengths of all the FRC post materials exceeded the yield strengths of the gold and stainless steel samples; the flexural strengths of two FRC materials were comparable with the yield strength of titanium. Stainless steel recorded the highest flexural modulus while the titanium and the two carbon fiber materials exhibited similar values just exceeding that of gold. The remaining glass fiber materials were of lower modulus within the range of 41-57 GPa. Weibull modulus values for the FRC materials ranged from 16.77 to 30.09. Decreasing the L/D ratio produced a marked decrease in flexural modulus for all materials. **Significance:**

The flexural strengths of FRC endodontic post materials as new generally exceed the yield strengths of metals from which endodontic posts are made. The high Weibull modulus values suggest good clinical reliability of FRC posts. The flexural modulus values of the tested posts were from 2-6 times (FRC) to 4-10 times (metal) that of dentin. Valid measurement of flexural properties of endodontic post materials requires that test samples have appropriate L/D ratios. **PDF**

Stewardson, DA, Shortall, AC, Marquis, PM. **The effect of clinically relevant thermocycling on the flexural properties of endodontic post materials**. *J Dent. 2010 May;38(5):437-42. Epub 2010 Feb 25.*

Objectives: It is suggested that fibre-reinforced composite (FRC) posts have lower elastic moduli than metal posts and this will reduce the incidence of root fracture. However, the mechanical properties may be altered in the oral environment. The aims of this study were to determine the effect on the flexural properties of FRC and metal post materials produced by: (1) a thermocycling regime which was clinically relevant and representative of that which would occur during 1 year in the mouth and (2) storage for 1 year at body temperature. **Methods:** Nine FRC and two metal post material samples were sealed in polythene sleeves and thermocycled between 10 degrees C and 50 degrees C for 10,000 cycles. Additional samples were stored dry at 37 degrees C for 1 year. The flexural strength and moduli were determined by three-point bending and compared with untreated control samples. **Results:** Thermocycling and storage at 37 degrees C for 1 year decreased the mean flexural modulus of all materials. This was statistically significant for 8 of 11 materials after thermocycling, and 4 of 11 materials after storage at 37 degrees C ($p<0.05$). Thermocycling and storage at 37 degrees C produced a non-significant increase in yield strength for both metal post materials. Thermocycling significantly increased the flexural strength of Postec while it decreased for the other FRC materials. Storage at 37 degrees C increased the flexural strength of three FRC materials (significantly for Postec) while it was decreased among the other materials. **Conclusions:** Although some of the changes noticed in flexural properties were statistically significant, it is doubtful that they are of sufficient magnitude to affect clinical performance. **PDF**

*Tomazinho, F.S.F., Zaitter, S., Silva, S.R.C., Alfredo, E. and Y.T.C. Silva-Sousa, Y.T.C. **Flexural properties of fiber reinforced root canal posts.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #3115, 2010 (www.dentalresearch.org)*

Objectives: Fiber-reinforced composite (FRC) root canal posts have been introduced to be used instead of metal alloys and ceramics. The aim of this study was to investigate the fracture resistence of five different types of fiber post. **Methods:** The fiber posts selected for this study were DT Light-Post (RTD St Egreve, France), White Post DC (FGM), Exacto (Angelus), ReforPost (Angelus), Everstick (Sticktech). Five posts of each experimental group were subjected to three-point bending test in a universal testing machine an angle of 90◦. The test was carried out until fracturing of the post. Mean flexural strength and SDs were calculated and data statistically analyzed by ANOVA and Tukey's test. **Results:** Means and SDs of flexural strength (N) were: DT Light-Post: 99.88 (3.92), White Post DC: 108.56 (9.99), Exacto: 113.18 (2.26), ReforPost: 58.7 (5.24), Everstick: 84.6 (1.81). ANOVA indicated significant differences among de groups ($p<0,05$). The fracture load of the tested systems ranged from 51 to 116N and the flexural strength from 869 to 1414MPa. DT Light-Post (1345MPa) showed significantly higher flexural strengths than the other posts. ReforPost (988MPa) showed a significantly lower flexural strength than all other posts. **Conclusion:** The FRC-posts investigated showed significant differences regarding to fracture load and flexural strength .

Vadavadagi, SV, Dhananjaya, KM, Yadahalli, RP, Lahari, M, Shetty, SR, Bhavana, BL.. **Comparison of different post systems for fracture resistance: an in vitro study.** *J Contemp Dent Pract. 2017 Mar 1;18(3):205-208.*

Endodontic restoration becomes a challenging task for the clinician because of severe loss of coronal tooth structure owing to trauma, caries, restorative, and endodontic procedures. The restoration of these teeth requires the use of a post and core as individual units or as abutment supports for fixed or removable restorations in a predictable long-term manner. **Aim:** To compare and assess the compressive bond strength of glass, quartz, and carbon fiber posts restored with porcelain-fused-to-metal (PFM) crown. **Materials and methods:** A total of 45 upper central incisor teeth having straight root canals, similar anatomically root segments, and fully developed apices were selected. Teeth were divided into three groups of 15 teeth after endodontic treatment. Group I: Teeth inserted with the prefabricated glass fiber post. Group II: Teeth inserted with **the quartz fiber post**. Group III: Teeth inserted with carbon fiber post. The posts were placed and core was fabricated using composite restoration followed by PFM crown cementation using adhesive resin. Compressive load required to fracture the tooth was measured using a universal loading machine. The difference between the variables was assessed by one-way analysis of variance, followed by Tukey's post hoc test. **Results:** The compressive strength exhibited by carbon fiber posts was highest with a mean of 668.33 ± 26.397, followed by quartz fiber post (635.80 ± 30.390). Least compressive strength was exhibited by glass fiber post (567.53 ± 26.632). An analysis of variance shows statistically highly significant difference ($p < 0.005$) among the posts used. **Conclusion:** This study concluded that the carbon fiber posts had higher compressive strength than other quartz, glass fiber posts. **Clinical significance:** Endodontic treatment results in loss of a significant part of the tooth structure. Posts restore these teeth and provide retention.

Vichi, A, Vano, M, Ferrari, M. **The effect of different storage conditions and duration on the fracture strength of three types of translucent fiber posts.** *Dent Mater. 2008 Jun;24(6):832-8. Epub 2007 Dec 3*

Objectives: (a) To evaluate the effects of storage duration, storage condition and type of fiber post on post fracture strength. (b) To morphologically evaluate the post structure before and after storage. **Methods:** Three types of fiber posts were divided in different groups (n=14) according to the storage duration (1, 6, 12 months), and storage condition (dry at 37 degrees C; saline water

degrees C). Specimens were loaded in a universal testing machine with a compressive load until fracture. A 3-way ANOVA and Tukey's test (alpha=.05) were used to compare the effect of the experimental factors on the fracture strength. Two posts of each group were observed before and after the storage using a scanning electron microscope. **Results:** Storage conditions and post type, had a significant effect on post fracture strength ($p<0.05$). The interaction between these factors was significant ($p<0.05$). Water storage significantly decreased the fracture strength, regardless of the post type and the storage duration. Storage inside roots, in oil, and at dry conditions did not significantly affect post fracture strength. SEM micrographs revealed voids between fibers and resin matrix for posts stored in water. Posts stored under the other conditions showed a compact matrix without porosities. **Significance:** Fiber posts placed inside human root canals immersed in water are not affected by the detrimental effect of water.

B. FATIGUE RESISTANCE

*Grandini, S., Goracci, C., Monticelli, F., Borracchini, A., Ferrari, M. **An evaluation, using a three-point bending test, of the fatigue resistance of certain fiber posts.** *II Dentista Moderno, March, 2004, 70-74*

Aim: The aim of the present study was to assess the fatigue resistance of several types of fiber posts by using a 3-point bending test and to observe their ultrastructure through Scanning Electron Microscopy (SEM) before and after undergoing the fatigue test. **Methods:** Six types of fiber posts were selected for this study, EasyPost (Group 1), ParaPost Fiber White (Group 2), FibreKor (Group 3), D. T. Light-Post (Group 4), Lucent Anchors (Group 5), and SnowPost (Group 6). Each group contained 15 posts; 5 posts in each group were observed with SEM, the other ten were used for the fatigue test. A three-point bending machine, loading at an angle of 90 degrees and a frequency of 3 Hz, was employed for fatigue testing. The test was carried out until 2 million cycles were completed or until the post fractured. After the fatigue test had been completed, further evaluations were carried out with SEM on the fractured posts and the posts that went to the end of the fatigue cycles. **Results:** The fatigue test showed statistically significant differences among the different posts. Group 4 (D.T. Light-Post; RTD, St Egreve, France)) performed better than all the other groups, withstanding the entire load cycles without fractures. **Conclusions:** There are great variations in the responses of different kinds of fiber posts to a fatigue resistance test. Structural integrity is already very different even before undergoing the fatigue test, and this proves that many of the performance differences noted are due to the differences in the manufacturing processes of the fiber posts. **PDF**

*Grandini, S., Goracci, C., Monticelli, F., Tay, F., Ferrari, M. **Fatigue resistance and structural characteristics of fiber posts: three-point bending test and SEM evaluation.** *Dental Materials (2005) 21,75-82*

Objective: This study evaluated the fatigue resistance of different types of fiber posts subjected to a fatiguing procedure with a 3-point bending machine. **Methods:** Eight types of fiber posts were selected for this study: Group 1 Easypost (Krugg, Milano, Italy), Group 2 ParaPost Fiber White (Coltene/Whaledent, Mahwah, NJ, USA), Group 3 FibreKor Post (Pentron Technologies, Wallingford, CT, USA), Group 4 Ghimas White (Ghimas, Casalecchio, Bologna, Italy), Group 5 D.T. Light-Post (RTD, St Egreve, France), Group 6 FRC Postec (Ivoclar/Vivadent, Schaan, Liechtenstein), Group 7 Lucent Anchor (Dentatus, New, York, USA), and Group 8 Fototech (Isasan Carbotech, Caronno Petrucella, Italy). Each group included 10 posts. A three-point bending machine, loading at an angle of 90^0 and a frequency of 3 Hz was employed. The test was carried out until 2,000,000 cycles were completed or the post fractured. One-way ANOVA, followed by the Bonferroni test for multiple comparisons was performed to evaluate the 8 groups. The level of significance was set at $p<0.05$. **Results:** The fatigue test showed statistically significant differences among the different posts. Groups 5 (D.T. Light-Post) and 6 (FRC Postec) performed significantly better than all the other groups; withstanding the entire cycle of loads. All of the other posts fractured before the end of the test. **Conclusions:** the statistical analysis is highly significant: different kinds of posts give different results when they undergo a fatigue resistance test. **PDF**

*Grandini, S., Chieffi, N., Cagidiaco, M.C., Goracci, C., Ferrari, M. **Fatigue resistance and structural integrity of different types of fiber posts.** *Dent Mater J. 2008 Sep;27(5):687-94.*

The study aimed at assessing and estimating the fatigue resistance of different fiber posts and to observe their ultrastructures through SEM. Six types of fiber posts were used: GC Fiber Post (Group 1), ParaPost Fiber White (Group 2), FibreKor (Group 3), DT Light-Post radiopaque (Group 4), FRC Postec (Group 5), and Luscent Anchors (Group 6). Ten out of 15 posts within each group were used for the fatigue test, and the other five were processed for SEM evaluation. The fatigue test revealed that Groups 1, 4, and 5 performed better than all the other groups, and that their performance differed significantly from the other tested groups from a statistical standpoint. For SEM analysis, Groups 1, 4, and 5 also obtained better results. Through correlation analysis, an absence of correlation between fatigue resistance and structural characteristics suggested that the latter reflected more of the divergence inherent in the manufacturing process of fiber posts.

C. RADIOPACITY

*Denny, D., Heaven, T., Broome, J., Weems, R. **Radiopacity of luting cements and endodontic posts .** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #0675, 2005* (www.dentalresearch.org)

The lack of radiopacity found with some nonmetallic prefabricated radicular posts in combination with the luting cement can make radiographic interpretation difficult. Objective: This study evaluated the radiographic density of nine cements and eleven posts. Methods: Cements tested were: ZnPO4 (Z) Mizzy; Duolink (DL), Hi-X (HX) Bisco; Ketac Cem (KC); Rely X ARC (RA), Rely X Luting (RL), Rely X Unicem (RU) 3M ESPE; Panavia F (PF) Kuraray; Variolink (V) Ivoclar. Posts tested were: D.T. Light Post (DT) RTD, St Egreve, France; Twin Luscent Anchor (TLA) Dentatus; Parapost XP steel (XP); Parapost XT titanium, (XT); Fiber White (FW), Whaledent; Achromat (A) Axis; Fibrekor (FK) Pentron,; FRC Postec (FRC) Ivoclar. Individual radiographs of each specimen and a continuous aluminum ramp were made using D-speed film (Kodak). These films were scanned and analyzed with NIH Image software. Data were analyzed with a one-way ANOVA and Tukey-Kramer at α=0.05. Results: The mean (sd) density of the cements in terms of equivalent thickness of aluminum were: Z 4.50 (0.45)a, V 3.82 (0.19)b, HX 3.42 (0.27)c, RU 1.57 (0.23)d, RA 1.07 (0.10)e, KC 1.06 (0.17)e, RL 1.02 (0.21)e, DL 0.64 (0.14)f, PF 0.60 (0.24)f. The density of the posts were: XP 11.12 (0.15)a, XT 5.56 (0.18)b, **A 1.74** (0.07)c, DT 1.65 (0.12)c, FRC 1.34 (0.12)d, FK 1.05 (0.14)e, FW 0.61 (0.10)f, TLA 0.38 (0.10)g, Means of groups with the same superscript were not significantly different. Conclusion: ISO 4049 (2000) for polymer-based materials stipulates that a material must exhibit the radiopacity of an equivalent thickness of aluminum to be deemed radiopaque. Seven of the nine cements and six of the eight posts were found to meet the criteria.

Furtos, G., Baldea, B., Bratu, D, Prejmerean, C., Moldovan M. , Silaghi-Dumitrescu L**., Radiopacity of fiber posts.** *J Dent Res. Vol 88 (Sectional) Abstract #142, 2010* (www.dentalresearch.org)

Objectives: The aim of this study was to analyse the radiopacity of some glass/carbon fibers and metal post and to compare with the radiopacity of human enamel and dentin. **Methods**: Four disks of each post (21 materials), mesiodistal sections of human molar (1±0.01 mm thickness) and aluminium step wedges were radiographed on dental X-ray films. After development, dental films were digitized by scan and radiopacity values were recorded for each sample. The radiopacity of the samples was expressed in terms of the equivalent thickness of aluminium per 1mm unit thickness of material. **Results:** ParaPost XP (Coltene Whaledent), FRC Postec Plus (Ivoclar Vivadent), Danville Ice Light (Danvile), Light Post, DT Light Post (RTD), showed radiopacity values higher than enamel, Glassix (NORDIN S.A), UniCore Post (Ultradent), Danville Ice Post (Danvile), ParaPost Fiber Lux, ParaPost TaperLux (Coltene Whaledent) showed radiopacity values significantly greater than dentin, while ParaPost Fiber-White (Coltene Whaledent), RelyX™ Fiber Post (3M ESPE), Mirafit White, Mirafit Carbon (Hager & Werken), Fibrapost (PDSA), Saremco posts Non-Stop Fibre (Saremco Dental AG), Aestheti-Plus, DT White Post (RTD), materials showed radiopacity values lower than dentin. Composites from Reforpost Glass Fiber (Angelus), Core post - Glass fiber post, Core post - Carbon fiber post (DenMat) had a radiopacity lower than dentin while the second component of these posts metal had a greater radiopacity than enamel. The results recorded showed statistically significantly differences (significance level = 0.05) when evaluated with One-Way ANOVA statistical analysis. **Conclusions:** Future fiber posts are recommended to have higher radiopacity values than dentin and perhaps ideally similar to or higher than that of enamel for improved of clinical detection. The posts with a lower radiopacity than 1 mm Al could be considered sufficiently radiopaque if the posts would be cemented with higher radiopaque cement. Further works in this direction are needed.

*Goracci, C, Juloski,J, Schiavetti, R, Mainieri, P, Giovannetti, A, Vichi , A, Ferrari, M. **The influence of cement filler load on the radiopacity of various fibre posts ex vivo.** *Int Endod J. 2015 Jan;48(1):60-7. doi: 10.1111/iej.12275. Epub 2014 Mar 20.*

Objective: To verify whether the filler load of luting agents influences the radiopacity of intraradicularly placed posts. **Methodology:** Digital radiographs of the following posts were taken: RelyX Fiber Post (3M ESPE), GC Fiber Post (GC Corporation), DT Light-Post Illusion (RTD), DT Light - Post SL (RTD), Endo-Composipost (RTD), FibreKleer Parallel Post (Jeneric Pentron Incorporated), FRC Postec (Ivoclar Vivadent), Parapost Taper Lux (Còltene/Whaledent AG), Radix Fiber Post (Dentsply Maillefer), EverStick Post (Stick Tech Ltd), Dentin Post X (Komet), Tech 21 X-op (Isasan), ENA Post (Micerium). Post radiopacity was measured in millimetres of aluminium (mmAl) with reference to an aluminium step wedge. Two extracted contralateral premolars were root filled. After post space preparation, taking the midpoint of the post hole as a reference, each tooth was cut longitudinally into two halves in a mesiodistal direction. On each half, the exposed root dentine was ground flat to the deepest point of the post space, and an even layer of cement was placed and light-cured. To obtain a clinically relevant layer of cement, the material thickness was reduced to 75 μm by grinding with wet abrasive paper. A cement formulation with 30 wt% of filler was tested in one premolar, whilst a formulation with 70 wt% of filler was utilized in the contralateral tooth. Posts were then placed between the two facing root halves of each premolar, and radiopacity was measured in mmAl. Data were analysed using t-test for paired samples ($P < 0.05$). **Results:** Radiopacity of posts ranged between 1.44 (ENA Post) and 5.78 mmAl (FibreKleer). In the presence of the more heavily filled cement, significantly higher values of post radiopacity were measured ($P < 0.001$). **Conclusion:**The radiopacity of the luting agent contributed to the overall post radiovisibility within the root. Even when the cement with lower filler content was used in combination with the least radiodense dowels, the post was detectable within the root.

Kaval, ME, Akin, H, Guneri, P. **Radiopacity of esthetic post materials: evaluation with digital analysis technique.** *J Prosthodont. 2015 Oct 29. doi: 10.1111/jopr.12386. [Epub ahead of print]*

Purpose: To evaluate the radiopacity of five post materials using a digital image analysis method. **Methods:** Twelve specimens from each post type (two zirconia and three fiber based) of 2 mm in thickness were obtained using a diamond blade mounted on a cutting machine, and digital radiographs were taken along with aluminum step-wedge and dentin discs under standard exposure conditions. The mean gray-values of specimens were measured using a computer graphics program. Data were analyzed using one-way ANOVA followed by Holm-Sidak multicomparison test ($p = 0.05$). **Results:** The highest radiopacity was observed in custom zirconia (5.842 millimeters of equivalent Al [mmAl]), and the lowest value was detected with FRC-Postec (Ivoclar Vivadent) (1.716 mmAl). Significant differences were revealed between the radiopacity values among all groups ($p < 0.05$), except the Zr post materials ($p = 0.56$). **Conclusions:** All tested post materials had higher radiopacity than dentin. Further studies will be required to clarify optimum radiopacity properties of the post materials to provide a precise clinical observation.

*McClendon, K., Ripps, A., Fan, Y. **Comparative study on radiopacity of fiber posts and resin cements**. *J Dent Res. Vol 89 (Spec. Iss. A) Abstract #253, 2010* (www.dentalresearch.org)

Objective: Various articles describe concern for the lack of opacity of glass fiber posts and resin cement bonding systems. The objective of this study is to compare the radiopacity of five different fiber post systems and the opacity of two commonly used resin cement systems to bond the fiber posts. **Methods:** The five fiber post systems [RelyX (R), Parapost (P), DT Light-Post Bisco/ RTD (B), Ivoclar (I), and Unicore (U)] and a Fluke Biomedical mammographic aluminum step wedge ranging from 0.4mm to 6mm thick with 15 steps were radiographed on a single film. RelyX Unicem and Ivoclar resin cements were also radiographed with the aluminum step wedge on a separate film. The opacity of each fiber post was converted to aluminum equivalents, as were the opacities of the two bonding resins, taking into consideration the diameter of the posts and thickness of the cement samples. **Results:** The average aluminum equivalent for RelyX was 1.764 ± .04, Parapost 1.62 ± 0.04, Bisco/RTD **2.400 ± 0.11**, Ivoclar is 2.425 ± 0.03, and Unicore 1.986 ± 0.05. RelyX Unicem resin cement yielded an aluminum equivalent of 4.243 ± 0.62 and Ivoclar yielded an equivalent of 3.194 ± 0.25. **Conclusion:** Statistical analysis revealed significant differences between all posts' mean normalized aluminum equivalent levels with the exception of Bisco and Ivoclar. Bisco and Ivoclar produced notably higher aluminum equivalents, signifying these fiber posts are much more radiopaque. The RelyX Unicem resin cement also had a considerably higher mean normalized aluminum equivalent level than Ivoclar, revealing a much more radiopaque.

Schmage, P., Wicht, HS, Nergis, I., P. Pfeiffer, P, **Grey level differences between different root post materials and dentin.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #820, 2010 (www.dentalresearch.org)*
Objectives: The visibility of a root post after insertion is required and depends on the post material and the radiographic system. The aim of the study was to compare grey level differences between different post materials and dentin using 3 radiographic systems. **Methods**: 5 extracted teeth each were positioned in row in a block of silicone. Root canals were prepared for posts of the Erlangen post system (Brasseler; size 2, length 9 mm). Posts of fiber-reinforced composite (FRC), ceramic (C), titanium (T) and gold alloy (A) as well as a gutta percha point (G) were positioned into the root canals, respectively. Gutta percha and the empty canals (E) served as a control. Radiographs (n=5) were taken with the digital systems XIOS (X, Sirona Dental Systems) and Vista Scan (V, Durr Dental) *and* compared with scanned dental F-speed films (F, Eastman Kodak). Grey level differences were evaluated between the root posts and the root dentin. Statistical differences were analyzed between groups (1-way and 3-way ANOVA, Scheff6 correction, 0=0.05). **Results:** The highest grey level differences were found for C and A (60 with F and 100 to 120 with both digital systems). Grey value differences of G and T ranged on the same level (20 to 40 with F and V, 50 to 80 with X). Lowest results were found for FRC (10 to 20) and E (-10 to -20). Significant differences were noted between C and A, and E, G, T and FRC, furthermore between G and T, and E and FRC ($p<0.001$). Grey level differences were significantly higher for anterior teeth compared to molars for F: G, C, T and A; for X: G, C, A; and for V: A ($p<0.05$). **Conclusion:** The post material, the tooth morphology as well as the radiographic system affect the grey level differences to dentin.

D. LIGHT CONDUCTIVITY

Bassi, F. Cerutti, F., Poletti, N., Gagliani, M., Re, D., Cerutti, A. **Endocanalar glass-fibre-post luting: Micro-raman analysis of dual-curing composites conversion degree.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 1911, 2009. (www.dentalresearch.org)*

Objective: Aim of this study was to evaluate the degree of conversion (DC) of composites cured throughout glass-fibre post, comparing different curing methods at increasing depths. **Methods:** Forty-five freshly extracted mono-radicular teeth were sectioned at the CEJ with a diamond-coated saw, endodontically treated and filled with warm gutta-percha. Samples were randomly divided into three groups (n=15), post spaces were prepared and glass-fibre posts (FRC Postec Plus, Ivoclar-Vivadent) were luted with three dual-curing composite materials, respectively: Calibra (Dentsply), Multilink Automix and Variolink II (Ivoclar – Vivadent). Light-curing was performed with the same halogen lamp (Swiss Master Light, EMS) employed with three different programs (400 mW/cm2 for 120s; 800 mW/cm2 for 60s; 1200 mW/cm2 for 40s), providing a constant amount of energy (48J). Samples were stored in physiological saline in a sealed box for 24 hours at 37°C, then 1 mm-thick slices were cut. Slices corresponding at 1, 3, 5 and 7mm of depth from the CEJ were analysed with MicroRaman HR Spectrometry at 0° and 180°. The data were

statistically analysed by ANOVA (p<0,05), then compared to data collected in a previous in vitro study based on the same protocol. **Results:** DC was considered as a function of depth: from this point of view, no significant difference was found between the composites DC. Considering DC as a function of the curing modality for each material, at the depth of 7 mm Variolink II acquires the best results when cured at 400mW/cm2 for 40s. Conversion mean values and SD are shown in Table.1. **Conclusion:** Materials with a dual component are recommended in post luting to ensure adequate monomer conversion at high depths. The features of each luting composite are exalted from different curing conditions that should be calibrated.

*Coutinho, M., Guerisoli, D., Faustino, F., Oliveira, S., Caires, C. **Degree of conversion of luting cement through translucent fiber posts.** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #1357, 2017(www.dentalresearch.org)*

Objectives: Quantify the intensity of light transmitted through translucent fiberglass posts (FP, Phase 1); the efficacy of this transmitted light on the degree of conversion (DC) of a dual resin cement (DRC, Phase 2) and; the DC of DRC by the light emitted by the curing unit through the FP (Phase 3). **Methods**: The FP (n=12/gp) used in this experiment were: White Post DC (WP), Exacto (EX) and DT Light-Post Illusion X-RO (LP). During phases 1 and 2, an opaque barrier was used to allow light transmission only through the FP, while during phase 3 the light was cast directly over the FP and the DRC system, on the cervical third of the simulated root canals. After 24hs, samples of the DRC were analyzed under FT-IR. Quantifications of the light transmitted through the FP and the DC of the DRC were performed at 2, 5 and 8mm. **Results**: Data were statistically analyzed (ANOVA and Tukey's, p>0.05), which showed that transmission of light through FP is similar between the different posts and decreases as they gain distance from the light emitting source. During phase 2, it was not possible to collect the DRC, since it dissolved during the sectioning of the samples, thus indicating that the light transmitted through the FP is not able to activate the setting reaction of the DRC. No differences were detected among the depths of DRC setting at phase 3 (p>0.05). A correlation was found between the DC and the amount of light transmission through FP. When comparing the radicular thirds, the apical portion presented a lower DC than the cervical and middle (p<0.0001) portions. **Conclusions**: It can be concluded that direct light incidence allowed a satisfactory DC of the DRC only at the cervical and middle portions of the canal, independently of the FP used.

De Castro Albuquerque, R. Morgan, L. A., Lourenço, B.F., Pinotti, M.B., Ferreira, F.M., Araújo, P.V., Poletto, L.T. **Radial transmission of light translucent fiber posts.** *J Dent Res. Vol 88 (Spec. Iss. B) Abstract #3104, 2010 (www.dentalresearch.org)*

Objectives: Due to the placement of cement related to the post after intraradicular cementation, the polymerization of both light-curing and dual resin cements depends on radially transmitted light energy. Methods: The aim of this study was to investigate radial light transmission through translucent fiber posts. Four fiber glass posts of different types and manufacturers were evaluated quantitatively. For the analysis, metal customized molds were constructed according to the precise dimensions of each post. The amount of light energy was measured at three different depths by a digital power meter. Values were subjected to the Kolmogorov-Smirnov, Levene, Kruskal Wallis, and Mann Whitney statistical tests (p<0.0125). **Results:** The values obtained indicated that the amount of radially transmitted light energy depends on the type of post used. All values presented a significant decrease in the amount of radially transmitted light, which was in direct proportion with an increase in depth. **Conclusion:** The results showed that the intensity of the light that is radially transmitted to the posts appears to decrease to levels that are insufficient for polymerization, especially in the apical third, thus confirming the hypothesis of this work.

* Dogar, A., Altintas, S.C., Kavlak, S., Guner, A. **Determining the influence of fibre post light transmission on polymerization depth and viscoelastic behaviour of dual-cured resin cement**. *Int Endod J. 2012 May 24. doi: 10.1111/j.1365-2591.2012.02085.x. [Epub ahead of print]*

Aim: To evaluate the effect of quartz-fibre posts on the depth of polymerization of a dual-cure resin cement using Raman spectroscopy and to determine the physical properties of the polymerized cement using a dynamic mechanical analyzer (DMA). **Methodology**: Twenty-five fibre (DT Light-Post, RTD St Egreve, France) and 25 CrNi posts were used to evaluate depth of polymerization. Posts were cemented with dual-cure resin into root canals formed from silicone moulds, without using bonding or etching agents. After polymerization, resin layers on each sample were removed using a curette and cut into three equal parts (apical, middle and coronal). All resin specimens for every third were gathered and crushed. Resin powder samples were analysed using Dynamic Mechanical Analysis and Raman spectroscopy for each third. **Results:** The numerical data revealed that the thermal transitions of the materials took place at higher temperatures from the apical to the coronal sections in both groups. C=C double bond intensity was lower in fibre post-resin cement samples when compared to their intensity in metal post-resin cement samples. **Conclusion:** Dual-cured resin cements had more rigid properties and better polymerization for fibre posts when compared with metal posts. Polymerization quantity was affected by position in the canal. **PDF**

Dos Santos, A., Morgan , LF, Peixoto, RT, de Castro Albuquerque, R, Santos Corrêa, MF, de Abreu Poletto, LT, Pinotti ,MB. **Light transmission through a translucent fiber post**. *J Endod. 2008 Mar;34(3):299-302.*

This study is a quantitative assessment of the luminous energy transmitted through different translucent fiber posts. After embedding the posts in black resin, the blocks were submitted to sequential cuts in a precision machine, and depths of 16 mm, 12 mm, 8 mm, and 4 mm were assessed for light transmission with a digital photometer. The quantitative analysis showed significant differences between different posts and depths. Furthermore, the values obtained revealed that the quantity of luminous energy transmitted depends on the type of post and that for all of them there was a significant reduction of the quantity of light transmitted as

the depth increased. Even without the post, the luminous intensity inside the canal seems to decrease to levels that are insufficient for polymerization, especially in the apical third.

Faria, E. Silva, AL, Arias, V.G, Soares, LE, Martin, AA, Martins, LR .**Influence of fiber-post translucency on the degree of conversion of a dual-cured resin cement**. *J Endod. 2007 Mar;33(3):303-5.*

This study evaluated the degree of conversion of one dual-cured resin cement when used to lute fiber posts with different translucencies. To measure the degree of conversion, polyvinylsiloxane molds were prepared to simulate root canals. The posts, Aestheti-Post or Light-Post, were cemented in these molds and, after photoactivation, were removed to obtain the resin cement spectrum by FT-Raman spectroscopy. Spectra were acquired at three depths: superficial, medium, and deep. For Light-Post, the resin cement at deep depth showed the lowest degree of conversion and no significant difference in degree of conversion was found between the other depths. For Aestheti-Post, the superficial depth presented a higher degree of conversion values than those in the medium and deep depths, which were not significantly different from each other. Light-Post exhibited a higher degree of conversion than that of Aestheti-Post only at medium depth. Light-Post effectiveness regarding the degree of conversion is dependent on the depth. **PDF**

Flores, M., Pendola,M., C. Avendaño, C., Varas, X., R. Schulz, R., Barrientos, P., SAHA, S. **Correlation of light transmission and microstructure in fiber-glass dental posts.** *J Dent Res.Vol 92 (Spec Iss A) Abstract #3189, 2013 (www.dentalresearch.org)*

Introduction: In glass fiber dental posts systems for dentistry, the adhesive layer plays a critical role in the treatment outcome. The quality of the cement layer is improved when photo-activation of the adhesive occurs, produced by the light transmitted across the glass fiber post. Therefore, ability for light transmission of a glass fiber post should be considered at the moment of selection of the best choice for treatment. **Objectives:** To evaluate the light transmission of three glass fiber dental posts with a simple and viable method, and correlate that transmission with the structure of the posts. **Method:** Inside a dark box, a regular curing light (Coltolux LED) and a digital photographic camera (Canon Rebel EO5 T1) were adapted. Groups of three types of glass fiber dental posts (FiberPost, 3M ESPE; EasyPost, Dentsply; Exacto, Angelus) were photographed inside the dark box, while exposed to the curing light. The pictures were taken with obturation speed of 1/8, aperture of 0.80 and resolution of 8 MP. Images were analyzed with Adobe Photoshop CS5 Extended (Adobe Systems Inc) and Matlab (MATLAB R2012b The MathWorks Inc., Natick, MA, 2000), to evaluate the differences of light transmission in every fiber glass post. **Result:** The three dental posts showed different levels of transmission. The FiberPost transmits more light compared to the other tested posts. Structure of the posts is being analyzed when the abstract is submitted. **Conclusion:** The photo-induction produced by the tested posts may be different. The group of 3M posts may produce a better photo-induction and it may have better conformation of adhesive layer and therefore better final outcomes.

Goracci, C., Corciolani, G., Visci, A., Ferrari, M. **Light- transmitting ability of marketed fiber posts. *J Dent Res87 (12):1122 -1126, 2008.*

If proper polymerization of resin-based cements is to be achieved for fiber post luting, light activation is needed for photo-curing agents, recommended for self-curing materials. The study was aimed at verifying whether the light-transmitting with a curing unit. Spectrophotometric measurements of the amount of photons reaching different post levels were taken. Data were statistically analyzed (linear regression, two-way ANOVA; alpha = 0.05). No light transmission was recorded through FibreKleer and Tech21 X-OP. For the other posts, light intensity decreased from coronal to apical and rose again at the apical tip, where it peaked for GC Fiber Post, Macro-Lock Illusion Post, and Radix Fiber Post. Light transmission was significantly higher at the coronal level. A statistically significant difference in translucency was found for Dentin Post X and FRC Postec Plus in comparison with Reforpost, FibreKleer, Tech21 X-OP, and Composipost. **PDF**

*Kim, Y.K., Kim, S. K. , Kim, K.H. Kwon, T.Y.. **Degree of conversion of dual-cured resin cement light-cured through three fibre posts within human root canals: an *ex vivo* study.** *International Endodontic Journal Volume 42 Issue 8, Pages 667 – 674*

Aim To evaluate the degree of conversion of one dual-cured resin cement light-cured through three fibre posts within extracted human teeth. **Method:** Fifteen mandibular premolars were root filled and then divided into three groups. Variolink II was light-cured through the posts (LP, D.T. Light-Post**;** PP, FRC Postec Plus; SP, Snowpost) within the root canal. The degree of conversion was obtained at 1 mm intervals in 9 mm-deep longitudinally sectioned root canals using an optical microscope connected to an FTIR spectrophotometer (n = 10). The light transmission of each post tested was also examined using UV–Vis spectroscopy. Data were analysed using ANOVA and Tukey's test (α = 0.05). **Results:** The LP and PP posts revealed a light transmission of 10.2% and 7.7%, respectively, whereas the SP post exhibited a significantly lower value of 0.5%. The degree of conversion mean value ranged from 32.78% to 69.73% depending on the depth and type of post. For all the groups, there were significant decreases in the degree of conversion values for the middle region when compared with those for the cervical region ($P < 0.05$). Except at a depth of 1 mm, the SP group consistently exhibited significantly lower degree of conversion values than the other groups ($P < 0.05$). The linear regression analysis revealed a strong correlation between the light transmission of the posts and the overall degree of conversion value for each group ($R^2 = 0.9888$). **Conclusions:** The decrease in the degree of conversion for Variolink II relative to the depth was dependent on the light transmission capacity of the posts tested. **PDF**

Lassilla, L. Vallittu, P. **Photopolymerization of fiber reinforced root canal post.** *J Dent. Res 81 (Spec Issue A) Abstract 3479, 2002. (www.dentalresearch.org)*

Objectives: During the last few years fiber reinforced composite (FRC) root canal post has been introduced to market. However, there still remains question of possible problem with the adhesion between highly crosslinked polymer matrix of FRC-posts and filler-composite. An alternative to resolve this problem FRC post simultaneously with the surrounding filler composite. The aim of this study was to determine the degree of conversion (DC) of resin matrix of FRC post polymerzed by light initiation in a simulated root canal. **Methods:** Four different lengths (7,12,18,24 mm) of cylinders were used as a model of root canal. Two groups of cylinders where used: cylinders in Groups 1 were filled only with dimethacrylate resin (StickResin, StickTech, Finland) only. Cylinders in Groups 2 were filled with continuous unidirectional E-glass fibers (StickClassics) that have been further impregnated with resin. Specimens were light-cured (Elipar, ESPE, Germany) for 40 sec from the top of the cylinders. The bottom of the cylinder was fixed on FTIR/ATR (Fourier Transform Infrared spectroscopy/Attenuated Total Reflectance) (Spectrum One, Perkin Elmer) sample accessory and polymerisation process was analysed. Degree of conversion (DC%) was calculated from the aliphatic C=C peak at 1638 cm^{-1}, normalised against the aromatic C=C peak at 1582 cm^{-1}: DC% = (1-C/U)x100%, where C=absorption peak of the cured specimen, where U=absorption peak of the uncured specimen. Spectra of the sample was recorded every 2.5 min up to 5 min. Each IR-spectra was recorded with 8 scans using a resolution of 4 cm^{-1}. **Results:** Regression line was fitted into both models with regression coefficients of 0.946 (resin, p=0.027) and 0.938 (fibers+resin, p=0.031). **Conclusions:** This in vitro study showed that sufficient degree of conversion could be achieved by exposing light from other end of glass fiber post.

Le Bell-Rönnlöf **A**-M., Närhi, T., Vallittu, P.,Lassila, L., **Transmission of light through fiber-reinforced composite posts.** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #3233, 2017(www.dentalresearch.org)*

Objectives: To achieve proper polymerization of fiber-reinforced composite (FRC) post and resin luting cement, good light transmission and scattering is needed. The aim of this in vitro study was to explore light transmission through FRC posts with different polymer matrices. Both prefabricated and individually formed FRC posts were tested. Effect of the length of the FRC post to light-transmission was evaluated. The hypothesis was that different FRC post materials have different light transmission properties. **Methods**: Five different FRC posts from different manufacturers were tested. Three groups included prefabricated FRC posts with a cross-linked polymer matrix (RelyX Fiber Post, GC Fiber Post, FibreKleer 4x Fiber Post). Two groups contained FRC posts with a semi-IPN (interpenetrating polymer network) polymer matrix (**everStick POST**, MI Core Fiber Post) one of which consisted of individually formed E-glass FRC posts (everStick POST). Various lengths of posts were tested: 4, 8 and 10mm (all posts parallel). Three FRC posts of similar length were made (n= 9/post group) and each specimen was tested three times. Light-protected molds of the same lengths as the specimens were made out of putty polyvinylsiloxane. Post preparation was drilled in the putty and posts were placed in the holes. The molds were placed on the test tray of a MARC Resin Calibrator unit and light-polymerized for 10 seconds with Elipar S10 (470nm) from a distance of 2mm. Light transmission in the direction of fibers was registered. Molds without posts were used as control. **Results**: The results are presented in the Table. Light transmission decreased with increased post length ($p < 0.001$; ANOVA) in all post groups. The prefabricated FRC post with a semi-IPN polymer matrix (MI Core Fiber Post) showed highest light transmission in all specimen lengths ($p < 0.001$).**Conclusions**: This study shows that a large variation in light transmission exists between different FRC post materials.

*Navarra, CH, Goracci, C, Breschi, L., Vichi, A., Corciolani, G, Cadenaro, M, Ferrari, M. **Influence of post type on degree of conversión of a resin-based luting agent.** *Am J Dent 2012;25: 17-20*

Purpose: to assess the degree of conversion (DC) at different levels of a resin-based looting agent used with different commercial posts. **Methods:** a resin-based alluding agent (Variolink II) was light-cured in a simulated dowel space in combination with a different fiber posts GC Fiber post (GC) , DT Light Safety Lock (SL) , Rely X Fiber post (RX), Reforpost (RE) DT Light-Post Illusion (LPI), FRC Postec Plus, (FP), Radix (RA), Snowpost (SP), Dentin Post (DP) Macro-Lock Illusion (MI) and Composipost (CP). After 24 hours,DC was accessed through micro-Raman analysis at the coronal, middle, and apical thirds. 2-way AVOVA and Tukey test were used for the post -hoc comparisons ($P<0.05$). **Results**: the results demonstrated that the post type, doll space level, and between-factor interaction were statistically significant ($P<0.001$) . Differences in DC were observed at different depths for RX, RE, LPI, SL, DP, MI and CP, decreasing from the coronal to the apical third. Although the resin-based luting agent should be able to polymerize in the absence of light, a higher DC was found following light irradiation (with a decreasing effect from the coronal to the apical third). **Clinical significance:** fiber post type influence the degree of conversion of the tested resin-taste moving agent.**PDF**

*Ozturk,O., Turp, V., Sen, D., Tuncelli, B., Ulukapi, H. **Evaluation of fiber post cementation with adhesive techniques.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #4487, 2010 (www.dentalresearch.org)*

Objective: The aim of this study was to compare the interfacial strength of dual-cured and self-cured resin cements when used in translucent fiber post cementation. **Methods:** Twenty endodontically treated, single canal, extracted human upper central incisors were selected. Translucent fiber posts (D.T. Light-Post, Bisco Dental / RTD-St Egreve France) were luted into the root canal us-

ing two different resin luting systems with dual-cured (Bisco Duo-Link) and self-curing (Bisco C&B) according to the manufacturer's instructions (n=10). The specimens were transversally sectioned into four slices of 1.00 +/- 0.05 mm thickness in order to perform the push-out tests. Push-out tests were performed at a crosshead speed of 1 mm/min by using a universal testing machine (Shimadzu AG-IS, Shimadzu, Japan). **Results:** The Data was statistically analyzed with One-way ANOVA and Tukey HSD tests ($P < .05$). Micro push-out bond strengths were significantly affected by the type of luting agent. Fiber-posts luted with self-cured resin cement showed higher bond strengths compared to posts cemented with dual-cured resin cement ($P < .05$). In both groups, adhesive failures between dentin and cement were observed. **Conclusion:** Self-cured resin cements showed high bond strength values where dual-cured resin cements were less effective. Therefore, self-cured resin cements are recommended for the cementation of transluscent fiber posts.

Ozcan, M, Zamboni, S, Valandro, F, Bottino, M, Bagis, B. **Microhardness of dual-polymerized resin cement around a translucent fiber post in the intraradicular environment.** *J Conserv Dent. 2011 Oct;14(4):370-373.*

Objectives: In this study, we evaluated the effect of photopolymerization on Vickers microhardness of dual-polymerized resin cement at three locations when a translucent quartz fiber post was used. **Methods:** Single-rooted bovine teeth received quartz fiber post systems (length: 12 mm) using a dual-polymerized resin cement. In Group 1, the posts were cemented but not photopolymerized, and in Group 2, the posts were both cemented and photopolymerized. After cementation, approximately 1.5-mm thick sections were obtained (two cervical, two middle, and two apical) for regional microhardness evaluations. **Statistical analysis:** Statistical analyses were performed using the SPSS software (ver. 11.0 for Windows; SPSS, Inc., Chicago, IL, USA). Microhardness (kg/mm(2)) data were submitted to two-way analysis of variance (two-way ANOVA) and repeated measures with microhardness values as the dependent variable and polymerization status (two levels: with and without) and root region (three levels: cervical, middle, and apical) as independent variables. Multiple comparisons were made using Dunnett's T3 post-hoc test. P values of <0.05 were considered to indicate statistical significance in all tests. **Results:** Photopolymerization did not significantly change the microhardness values when compared with no photo-polymerization. Micro-hardness values also showed no significant difference between the three regions in the root canals in both groups. **Conclusions:** The mode of polymerization of the cement tested in combination with the translucent quartz fiber post system did not affect the microhardness of the cement at the cervical, middle, or apical regions of the root. **PDF**

Valdivia, ADCM, Pereira, RD, Bicalho, AA , Tantbirojn, D. , Versluis, A , Soares, CJ. **Effect of photo-activation protocols for resin cements on shrinkage stresses**. *J Dent Res.Vol 92 (Spec Iss A) Abstract #1120, 2013 (www.dentalresearch.org)*

Objective: Finite Element Analysis (FEA) was used to evaluate how time elapsed between mixing and polymerization affects the elastic modulus (E) and residual shrinkage stresses (Shr) for different resin cements as luting agent in incisors restored with fiberglass posts (FGP). **Method:** Post-gel shrinkage of RU-RelyX Unicem (3M-ESPE), BC-Biscem (Bisco), RA-RelyX ARC (3M-ESPE) and PF-Panavia F (Kuraray), was measured by strain gauge test (N=10). The E of the resin cements at 9 root depths was measured using dynamic indentation test. The photo-activation protocols were: I-light-curing immediate; 3m-three minutes and 5m-five minutes (N=3). 2D FEA models were created of an incisor restored with FGP to assess the Shr along the interface of the resin cement/root dentin. Stress results were evaluated by modified Von Mises criterion. **Result:**Post-gel shrinkage decreased up to 70% with increasing photo-polymerization delay. The data shows E (mean, GPa)/Shr (MPa) in cement. **Conclusion**: The 5 minutes delayed photo-activation protocol decreased the Shr and improved the E of all resin cements.

Patyk, A., Friedrich, M. **Translucency of glass-fiber-reinforced resin posts.** *J Dent. Res 83 (Spec Issue A) Abstract 1784, 2004. (www.dentalresearch.org)*

Objectives: In addition to their dentinoid biomechanical properties, glass-fiber-reinforced resin posts offer advantageous optical properties because of their translucency. The study aims at comparing the translucency of four different factory-made glass-fiber-reinforced posts for visible light at a wavelength of 420 mm. **Methods:** In a first step, the transfer of light through the post was documented fotographically. The following three post systems were compared: - FRC Postec® (Ivoclar Vivadent, Schaan/Liechtenstein) - Twin Luscent Anchors® (Dentatus, Hägersten/Sweden) - Para Post® Fiber White (Coltène Whaledent, Konstanz, Germany) In a second step, the degree of light polymerisation was qualified by measuring the hardness of the surrounding composite cement in dependence of the exposure time with the Knoop hardness test (14.000 measurements). The horizontal and vertical distances between the measuring points were 0,2 mm. The reference value was the hardness of composite cement having directly been exposed to light. **Results:** Whereas the photographs of the light transfer in the FRC Postec® and the Twin Luscent Anchors® system show a slightly decreasing intensity of the emitted light from the head of the post to its apex, in the Para Post® system an emission of light is found only in the head region. The results of the Knoop hardness test show that under 60 sec. of light exposure, the reference value of hardness is reached up to an apical depth of 5 mm. Under 120 sec. of light exposure, the reference value is reached up to a depth of 7,8 mm (Twin Luscent Anchors®) respectively 7,4 mm (FRC Postec). **Conclusion:** The results show, that the different geometrical shapes of the post systems have no significant influence on the polymerisation process. The crucial factor for the polymerisation depth is the duration of exposure to light, which should be at least 100 seconds.

*Radovic, I., Gabriele Corciolani, G., Magni, E., Krstanovic, G., Pavlovic,V. Zoran, R. Vulicevic, P., Ferrari, M. **Light transmission through fiber post: The effect on adhesion, elastic modulus and hardness of dual-cure resin cement**. *Dental Materials 25 (2009) 837–844*

Objectives: The aim of this study was to investigate the effect of fiber post light transmitting ability to the continuity of resin cement-root dentin (C-RD) and resin cement-fiber post (C-FP) interface, elastic modulus and hardness of a dual-cure resin cement. **Methods:** Spectrophotometric measurements were applied for the determination of light transmission at coronal, middle and apical level as well as at the apical tip through Tech 21 X-OP (TECH) and DT Light- Post (DT) (RTD; St Egreve, France). Posts were cemented using dual-cured resin cement (Calibra). Roots were sectioned longitudinally through the post. Epoxy resin replicas were made and used to evaluate C-RD and C-FP interface under SEM. Modulus of elasticity (E) and Vicker's hardness (VH) of the cement layer were assessed. **Results:** No light transmission was detected through TECH. Light transmission through DT decreased from coronal to apical and rose at the apical tip. TECH presented a significantly lower percentage of continuous C-RD and C-FP interface in comparison to DT. Coronal third of C-RD interface in TECH specimens had a significantly higher percentage of continuity than apical third. No regional differences in continuity of C-RD interface were found in DT specimens. E and VH were significantly lower when TECH was used, and decreased from coronal to apical for both posts. **Significance:** Cementation of fiber post with no light transmitting ability using a dual-cured resin cement resulted in lower E and VH of the cement layer, and a lower percentage of continuous C-RD and C-FP interface in comparison to cementation of light transmitting fiber post. **PDF**

Sawada, N, Hikage, S, Sakaguchi, K, **Shape of composite resins photopolymerized by the translucent post**. *J Dent Res.81 IADR Abstract #2569; 2002 (www.dentalresearch.org)*

Objectives: The purpose of this study was to investigate light transmission of a glass fiber post (GFP Light-Post #3; RTD St Egreve, France/Bisco) from the shape of polymerized dental resins. **Methods**: The GFP was inserted into composite resins (Lite-Fil II A Shade E1 and Lite-Fil II P Shade A3 (Shofu) in a 1.5ml microtube. The upper end of the post was irradiated with a visible light generator (Griplight II, Shofu) for 20, 40 or 60 seconds. After polymerization, the unpolymerized resin around the GFP was measured. The length (A) of the polymerized resin, the diameter (B) of the upper surface and the diameter (C) of the resin 10mm below (B) were measured. Three samples were measured for each set of conditions. The data were statistically analyzed by Student's t-test. **Results**: Results showed that irradiation for 20 seconds was insufficient for polymerization, and the measurements of the samples were not possible. In the E1 resin, the value for (A) after irradiation for 60 seconds (15.5 +/- 0.3mm) was significantly larger than after 40 seconds (13.7 +/- 1.1mm) ($p<0.05$). In addition, the diameters of (B) were 3.7 +/-0.3 (40 seconds) and 5.3 +/- 0.3 (60 seconds), and the diameters of (C) were 6.7 +/- 0.7 (40 seconds) and 8.8 +/- 0.2 (60 sec). In the A3 resin, the extent of the resin polymerization was smaller than that in E1, although the value for (A) in the A3 resin was not significantly different from that in E1. **Conclusions**: Consequently, it was concluded that the composite resins were photopolymerized using the GFP. These results suggest that irradiation of a GFP (Light-Post #3) for over 40 seconds can effectively polymerize a highly translucent resin in clinical practice.

*Teixeira, C.S., Felippe, M.C.S., Felippe, W.T., Silva-Sousa, Y.C., Sousa-Neto, M.D.. **Storage-period influence on the composite resin hardness after root reinforcement.** *J Dent Res. Vol 88 (Spec. Iss. B) Abstract #4568, 2010 (www.dentalresearch.org*)

Objectives: This study verified the Vickers hardness (VHN) of a composite resin (CR) after root reinforcement, according to the light-curing time, root region and storage period. **Methods:** Twenty 17-mm long roots were used. Twenty-four hours after obturation, the canal was emptied to a depth of 12 mm, enlarged with diamond points, filled with CR and light-activated through the DT Light-Post fiber post for either 40 s or 120 s. After 24 h, each root was sectioned into 3 slices at depths of 2, 6 and 10 mm (n = 30). The initial VHN of the CR was measured as the average of 3 indentations (100g/15s), at lateral distances of 50, 200 and 350 μm from the cement/post. The specimens were stored in water for 18 months and the final VH was measured. **Results**: The ANOVA for repeated measures ($\alpha = 0.05$) indicated that the factors light-curing time, reinforced region and storage period influenced VH values. In the deepest regions, the hardness of CR was lower, regardless of the storage period. The mean VHN values of CR light-activated for 40 or 120 s were similar in the initial period ($p > 0.05$) but different after storage for 18 months ($p < 0.001$). In the group cured for 40 s, there was reduction and statistically significant difference ($p < 0.001$) between mean VHN values of the RC obtained initially and after 18 months of storage. In the specimens cured for 120 s, there was no statistical difference between the periods ($p > 0.05$). **Conclusions:** The 18 months storage period reduced mean VHN values in specimens light-activated for 40 s. The light-curing time of 120 s was able to maintain the hardness of composite resin stable over time in all regions.

Zamboni, S., Nogueira Junior, I., Vanderlei, A,. Bottino, M.A., Zamboni, T. **Does the light activation through post is enough? *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2192, 2010 (www.dentalresearch.org)*

Objectives: The purpose of this study was evaluated the microhardness of a dual cement used at the cementation of translucent posts, in differents depths, with or without light cure activation. **Methods:** Ten single-rooted bovine teeth were used. The crownes were removed, and standardized sizes of 16mm were used. The canal root was prepared with burs nº 3 of Macro-Lock Post system (RTD). The roots were painted with black nail varnish to block the passage of light. The teeth were treated with Adhesive System All Bond 2 (Bisco), and the posts Macro-Lock /RTD) with Duo-link dual cement, which changed the activation method: A- with-

out light-cured activation; B- with light cured activation (Optilight Plus, Gnatus, 500mW/cm²). The specimens were cut transversally, obtaining six slices with a thickness of 1,5mm. The cuts were divided according to their places (cervical, middle and apical) and the microhardness FM 700, Futuretech (Vickers, 50g/ 70s) of cement was estimated. The set groups were: G1- cervical without light cure activation; G2- middle without light cure activation; G3- apical without light cure activation; G4- cervical light cured; G5- middle light cured; G6- apical light cured. **Results:** Data were submitted by the statistics (ANOVA and TUKEY– α=5%). The light-cured groups (G4: 29,12±2,47, G5: 28,17±1,85, G6:28,52±1,67) obtained more significant values than the groups without light-cure activation (G1:24,64±1,87, G2:15,72±0,89, G3:14,90±0,45). Among the places, were could observe that a harder part was noticed in those group without light cure activation; meanwhile the places of this group didn't show any significant difference. **Conclusion:** The activation of polymerization with halogen light of dual cement and the transmission of light through of translucent post were able to increase the cement hardness.

*Zanatta, RF., Tavares, RDP, Barreto, BC, Soares, C.J. **Polymerization effect through translucent fiberglass posts in self-adhesive resin cements.** *J Dent Res. Vol 91 (Spec. Iss. B) Abstract #2744, 2012* (www.dentalresearch.org)

Objective: Test capacity of 3 translucent fiberglass posts to transmit light to cure self-adhesive resin cement simulating different depths of root canal. **Method:** Degree of conversion (%DC) was monitored using the Fourier Transform Infrared Spectroscopy (FTIR). A Teflon device with a central orifice correspondent to the posts geometry was produced to simulate the root canal. The device consists of 5 rings (2mm in height each) that enable measure %DC in 10, 8, 6, 4 and 2 mm of the posts, and a last ring (1mm in height and 1.5mm of central orifice) where self-adhesive resin cement was set. The device was placed on spectrometer sample holder; cement was manipulated according manufactory instructions and after chemical polymerization (3 minutes) it was light-activated. Halogen and LED light was tested. Data were submitted to homogeneity analysis and 3-Way Anova test ($p<0.05$) **Result:** Table 1 shows means and standard deviation of %DC for fiberglass post and polymerization lights. Great depths showed smaller %DC for all posts. **Conclusion:** Translucent fiberglass posts are able to transmit light to cure self-adhesive resin cement and the length of the post interfered negatively in the cement polymerization.

E. Diametral Tensile Strength

Chaney, A., Schulze, K., Roetzer, P., Chann, G., Alenezi, H., Bhattacharyya, M. **Diametral tensile strength and cost-effectiveness of commercially available fiber posts. *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #0739, 2017 (www.dentalresearch.org)*

Objectives: The goal in this study was to evaluate the difference of diametral tensile strength (DTS) obtained from commercially available fiber posts for cementation in root canals. The price of each fiber post was then compared with the DTS to evaluate the cost-effectiveness. The null hypothesis was that there is no difference between the cost-effectiveness among the manufacturers. **Methods**: Commercially available fiber posts from 12 different companies were selected (size 1.5 in diameter). The following manufacturers and post types have been included in the study. 3M ESPE–RelyX Fiber Post; Synca-Biolight DUAL; Denmat–Core-Post; GC–Fiber Post; Danville–Ice lite; **RTD–Macro-Lock Post X-RO**; Ultradent–Unicore; VOCO–Rebilda Post; Kerr Achromat-Axis; **Bisco-D.T. Light-Post**; Pentron-FibreKleer; Henry Schein-Precision Post. All posts can be used for build-up placements after root canal performance. Ten posts from each group were sectioned perpendicular to the long axis with a slow-speed-diamond saw (Buehler) to obtain 1mm thick slices from the parallel end of the post. The slices were then subjected to a diametral tensile strength test in a universal testing machine (INSTRON-1011) at a crosshead speed of 1mm per min until failure in static testing mode. Regression analysis using R statistical software has been used at a 95% confidence interval. Prizes have been compared to mean strength values to determine the cost-effectiveness of the fiber posts. **Results**: Average diametral strength values in MPa (±std dev) have been evaluated. A statistical significant difference among groups has been found p= 2e-16. The three most cost-effective manufacturers were: Henry Schein, RTD and Pentron with 0.21, 0.22, 0.23, respectively. The null hypothesis was rejected. **Conclusions**: RTD had the highest DTS while Henry Schein had the best cost-effectiveness.

Chaney, A., Schulze, K., Roetzer, P., Alenezi, H., Bhattacharyya, M. **Diametral tensile strength tests of different commercially available fiber posts. *J Dent Res. Vol 95 (Spec. Iss. A) Abstract #1862, 2016 (www.dentalresearch.org)*

Objectives: The goal in this study was to evaluate the difference of diametral tensile strength obtained from commercially available fiber posts for cementation in root canals. The null hypothesis was that there is no difference between the manufacturers in strength. **Methods**: Commercially available fiber posts from eight different companies were selected in two different size ranges(1.2mm and 1.5mm in diameter).The following manufacturers and post types have been included in the study. Group 1:3M ESPE–RelyX Fiber Post; Group 2: Synca-Biolight DUAL; Group 3: Denmat–Core-Post; Group 4:GC–Fiber Post; Group 5: Danville–Ice-Light; Group 6: RTD–Macro-Lock Post X-RO; Group 7:Ultradent–Unicore; Group 8:VOCO–Rebilda Post. All posts can be used for build-up placements after root canal performance. Ten posts from each group were sectioned perpendicular to the long axis with a slow-speed-diamond saw (Buehler) to obtain 1mm thick slices from the parallel end of the post. The slices were then subjected to a diametral tensile strength test in a universal testing machine INSTRON 1011 at a crosshead speed of 1mm per min until failure in static testing mode. Regression analysis using R statistical software has been used at a 95% confidence interval. **Results**: A statistical significant difference among groups has been found p= 2e-16. The null hypothesis was rejected. **Conclusions**: Group 6, the Macro Lock Post X-RO system from RTD, had the highest diametral tensile strength among all the groups

III. Mechanical Properties; interaction with tooth

A. Fracture Strength of restored teeth (see also Customized Low-Modulus Restoration section)

Abo El-Ela, OA, Atta, OA, El-Mowafy, O. **Fracture resistance of anterior teeth restored with a novel nonmetallic post.** *J Can Dent Assoc. Jun;74(5):441 2008*

Objective: To determine the fracture resistance of endodontically treated anterior teeth restored with a novel nonmetallic post in combination with self-etching adhesives. **Methods:** Extracted maxillary anterior teeth were sterilized with gamma irradiation, and each crown was severed 2 mm above the cementoenamel junction. Endodontic treatment was performed, and the teeth were divided into 7 test groups according to the post-adhesive combination used (n = 8 in each group). The following combinations of posts and adhesives were used: group 1, ParaPost stainless steel post with glass ionomer cement (control group); group 2, Light Post post with Clearfil SE Bond bonding agent and Panavia-F adhesive; group 3, Light Post post with Xeno-III bonding agent and Panavia-F adhesive; group 4, ParaPost Fiber White post with Clearfil SE Bond bonding agent and Panavia-F adhesive; group 5, ParaPost Fiber White post with Xeno-III bonding agent and Panavia-F adhesive; group 6, everStick post with Clearfil SE Bond bonding agent and Panavia-F adhesive; and group 7, everStick post with Xeno-III bonding agent and Panavia-F adhesive. Core build-ups to restore anatomic form were made from light-cured composite (TPH3). Specimens were stored in water at 37 degrees C. The roots of each tooth were embedded in an acrylic base, and the teeth were mounted at 135 degrees to the horizontal. The teeth were loaded in an Instron machine, and loading was applied to the point of fracture. Fracture loads were recorded, means and standard deviations (SDs) were calculated, and the data were analyzed with analysis of variance (ANOVA) and Tukey"s tests. **Results:** The mean fracture load (and SD) for each group was as follows: for group 1, 536.8 (75.1) N; for group 2, 1,000.1 (190.9) N; for group 3, 1,049.9 (231.5) N; for group 4, 1,548.5 (290.0) N; for group 5, 1,171.3 (296.9) N; for group 6, 1,711.7 (516.7) N; and for group 7, 1,825.7 (527.3) N. ANOVA revealed significant differences among the groups ($p < 0.001$). In addition, the mean fracture value for group 7 was significantly higher than those of the other groups $p < 0.05$) except for groups 4 and 6. **Conclusions:** Use of a novel glass fibre post (the everStick post) was associated with the highest mean fracture force for maxillary anterior teeth, regardless of the bonding agent used, whereas the stainless steel post was associated with the lowest mean fracture force. **PDF**

Adanir, N., Belli, S. **Evaluation of different post lengths' effect on fracture resistance of a glass fiber post system.** *Eur J Dent. 2008 Jan;2(1):23-8.*

Objectives: The purpose of this in vitro study was to evaluate the influence of different post lengths upon root fracture resistance. **Methods:** 78 maxillary central teeth with similar dimensions were mounted in acrylic blocks with artificial silicone periodontal ligaments. Combinations of post lengths of 6 mm (shorter than 1/1 clinical crown length), 9 mm (1/1 clinical crown length), and 12 mm (longer than 1/1 clinical crown length) made up 6 different groups consisting of 13 teeth each. The glass fiber posts (Snowpost) were cemented with Super-Bond C&B and Panavia F luting cement. Composite-resin cores were made with Clearfil PhotoCore. The specimens were tested in a universal test machine. The testing machine applied controlled loads to the core, 2 mm from its incisal edge, on the palatal side at an angle 135 degrees to the long axis of the root. The testing machine was set at a crosshead speed of 5mm per minute. All samples were loaded until failure. **Results:** There was no statistically significant difference between cements (P>.05). Posts shorter than clinical crown length demonstrated root fracture under significantly lower loading forces (P<.05). **Conclusion:** Usage of posts shorter than clinical crowns should be avoided to eliminate clinical failure.

*Adanir, N, Ureyen Kaya, B, Kececi, AD. **Fracture resistance of roots restored with four different fiber-reinforced composite posts.** *Med Princ Pract. 2015 Jun 23. [Epub ahead of print]*

Objective: The aim of this study was to compare the resistance to vertical root fracture of root-filled teeth restored with four different fiber-reinforced composite (FRC) post systems and two types of dual-cured resin luting agents. **Methods:** Ninety extracted human maxillary central incisors were selected and decoronated to obtain a standardized root length of 14 mm. After root canal obturation, post spaces were prepared to a depth of 10 mm with a No. 3 post drill. The specimens (n = 80) were divided into two groups (n = 40) according to the resin luting agents used: group 1, Variolink II + ExciTE DSC; group 2, RelyX Unicem. These groups were subdivided into four subgroups (n = 10) and restored with one of the following post systems: (a) DT Light, (b) DT Light SL, (c) FRC Postec and (d) Everstick, while the remaining 10 teeth served as controls. The roots were subjected to axial compressive loading using a 2.2-mm-diameter metal sphere in a universal testing machine (0.5 mm/min). A factorial experiment with a single control group (analysis of variance) was used to test the resistance of the specimens. **Results:** Groups 2a (DT Light + RelyX Unicem; 398.5 N) and 1b (DT Light SL + Variolink II + ExciTE DSC; 431.1 N) had significantly higher resistance to fracture than the control group (334.1 N; $p < 0.05$). DT Light SL and FRC Postec Plus were more resistant to fracture when Variolink II was used as the luting cement. DT Light and Everstick had higher fracture resistance when they were luted with RelyX Unicem ($p < 0.05$). **Conclusion:** The results of this study indicate that the use of quartz fiber posts (DT Light and DT Light SL) with an adhesive luting cement in root-filled teeth may reinforce the root to some extent. **PDF**

*Akkayan, B., Gulmez, T.: **Resistance to fracture of endodontically treated teeth restored with different post systems.** *J Prosthet Dent 2002; 87:431-7*

Statement of problem: Very little is known about the resistance to fracture of endodontically treated teeth restored with newly developed esthetic post systems. **Purpose:** This in vitro study compared the effect of 1 Titanium and 3 esthetic post systems on the fracture resistance and fracture patterns of crowned, endodontically treated teeth. **Methods:** A total of 40 recently extracted human maxillary canines with their crowns removed were endodontically treated. Four groups of 10 specimens were formed. Teeth were restored with Titanium (Filpost), quartz fiber (D.T. Light-Post), glass fiber (ParaPost White) and Zicronia (Cosmopost) posts and numbered as groups 1, 2, 3 &4, respectively. All posts were cemented with Single Bond dental adhesive system and dual-polymerizing RelyX ARC adhesive resin cement. All teeth were restored with composite cores, and metal crowns were fabricated and cemented with glass ionomer cement. Each specimen was imbedded in acrylic resin and then secured in a universal load testing machine. A compressive load was applied at a 130-degree angle to the long axis of the tooth until fracture, at a cross-head speed of 1mm / min. One-way analysis of variance and a Tukey test were used to determine the significance of the failure loads between groups (P<.001). A non-parametric $\mathbf{X}^2$ test was conducted for evaluation of the mode of failure (P<.001). **Results:** The mean failure loads (kg) were 66.95, 91.20, 75.90, and 78.91 for groups 1 – 4, respectively. Teeth restored with quartz fiber posts (group 2) exhibited significantly higher resistance to fracture (P<.001) than the other 3 groups. Teeth restored with glass fiber and zirconia posts (groups 3 and 4) were statistically similar (P<.05). Fractures that would allow repair of the tooth were observed in groups 2 and 3, whereas unrestorable, catastrophic fractures were observed in groups 1 and 4 (P<.001). **Conclusion:** Within the limitations of this study, significantly higher failure loads were recorded for root canal treated teeth restored with quartz fiber posts (D.T. Light-Post: RTD, St Egreve, France). Fractures that would allow repeated repair were observed in teeth restored with quartz fiber and glass fiber posts. **PDF**

*Akkayan, B. **An in vitro study evaluating the effect of ferrule length on fracture resistance of endodontically treated teeth restored with fiber-reinforced and zirconia dowel systems.** *J Prosthet Dent. 2004 Aug;92(2):155-62*

Statement of problem: There are few published studies analyzing the effects of different ferrule lengths of endodontically treated teeth in relationship to newly developed fiber-reinforced and zirconia dowel systems. **Purpose:** This in vitro study compared the effect of 3 different ferrule lengths on the fracture resistance and fracture patterns of crowned endodontically treated teeth restored with 4 different esthetic dowel systems. **Methods:** The crowns of 123 human maxillary canines were removed at the cementoenamel junction and the roots were endodontically treated. Three master tooth models were prepared to ferrule lengths of 1.0 mm, 1.5 mm, and 2.0 mm to produce 3 master analogs. Each root was embedded in autopolymerizing resin with a 0.2-mm layer of silicone impression material to simulate the periodontal ligament. Forty analogs of each master tooth, with ferrule lengths of 1.0 mm, 1.5 mm, and 2.0 mm were produced with copy-milling (Celay system). Each group was further subdivided into 4 groups of 10 specimens each and restored with 4 different esthetic dowel systems: quartz fiber (D.T. Light-Post- RTD St Egreve, France), glass fiber ER DentinPost/Brasseler-Komet, Germany), glass fiber plus zirconia (EasyPost, Dentsply-Maillefer, Switz.), and zirconia (CosmoPost, Ivoclar-Vivadent, Liechtenstein). All dowels were luted with adhesive resin cement (RelyX ARC), restored with composite cores (Valux Plus), and Ni-Cr alloy (Wiron 99) complete crowns. All specimens were loaded at 130 degrees to the long axes in a universal testing machine at a crosshead speed of 1 mm/min until fracture. Fracture patterns were classified as failures above or below the incisal third of the roots. The data were analyzed with 2-way ANOVA and Tukey HSD tests (alpha=.05). A Fisher exact test was conducted for evaluation of the mode of failure (alpha=.05). **Results:** Mean failure loads (kg) for quartz fiber, glass fiber, glass fiber plus zirconia, and zirconia groups, respectively, with the 3 ferrule lengths were: 1.0-mm ferrule specimens: 98.09 +/- 2.90, 85.36 +/- 2.82, 80.24 +/- 1.88, 70.11 +/- 2.48; 1.5-mm ferrule specimens: 101.0 +/- 2.88, 87.58 +/- 2.83, 89.8 +/- 2.09, 82.71 +/- 2.14; 2.0-mm ferrule specimens: 119.5+/-1.78, 99.84+/-1.23, 98.6 +/- 1.64, 95.42 +/- 1.02. Teeth prepared with 2.0-mm ferrules demonstrated significantly higher fracture thresholds (P<.001). There were no significant differences in fracture patterns. **Conclusions:** Increasing the ferrule length of the endodontically treated teeth from 1 mm to 1.5 mm in specimens restored with quartz-fiber and glass-fiber dowels did not produce significant increases in the failure loads (P=.084, P=.119, respectively). No significant difference was detected between glass-fiber and glass-fiber plus zirconia dowels with 1.5-mm and 2.0-mm ferrules (P=.218, P=.244, respectively). However, fracture thresholds were higher for all 4 dowel systems when the specimens were prepared with a 2.0-mm ferrule length (P<.001). **PDF**

Al-Wahadni, AM, Hamdan, S, Al-Omiri, M, Hammad, MM, Hatamleh, MM. **Fracture resistance of teeth restored with different post systems: in vitro study.** *Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008 Aug;106(2):e77-83. Epub 2008 Jun 13.*

Objective: The objective of this study was to investigate fracture resistance and mode of failure of teeth restored with different prefabricated post systems. **Study design:** Thirty teeth were collected, sectioned 15 mm from the apex, root canal prepared, and randomly allocated into 3 groups as follows: glass fiber posts (group 1), carbon fiber posts (group 2), and Radix-Anchor titanium posts (group 3). Teeth were then restored with a composite core and tested using a universal testing machine at 10 mm/min cross-head speed. Mode of failure was identified as either reparable or irreparable (catastrophic). **Results:** Mean values of fracture forces (N) for teeth restored with Radix posts (571.6) were statistically significantly higher than teeth restored with either carbon fiber (420.6) or glass fiber posts (393.9). There were 86.67% of fractures that were catastrophic in nature. **Conclusions:** Teeth

restored with Radix-titanium posts were more resistant to fracture than those restored with either carbon or glass fiber posts. Most of the fracture modes were catastrophic in nature. **PDF**

Aminsalehi, E., **Strength of incisors restored by metallic, fiber and ceramic posts.** *J Dent. Res 84 (Spec Issue B), African and Middle East Section 2005 (www.dentalresearch.org).*

Objectives: In endodontically treated teeth, because of extensive structural defects, the risk of fracture is increased. For reconstruction of coronal structure posts provide retention. Composite fiber posts were recently introduced to dentistry. This study compared the fracture strength of maxillary central incisors restored by metalic, fiber-reinforced composite and ceramic posts. **Methods:** 30 human maxillary central incisors were used. The crown of each incisor was cut off 1 mm coronally to C.E.J. perpendicular to long axis of the tooth by metal disc. Root canals of teeth were prepared for posts after RCT. Specimens were embedded in autopolymerizing acrylic resin 4 mm below the CEJ and then tested in a universal testing machine (Zwick-Germany). A compressive load was applied at 130 degrees to the long axis until fracture, at a cross-head speed of 0.5 mm/min. Fracture loads were recorded. All data collected were analyzed statistically using the ANOVA and LSD tests. **Results:** The mean and standard deviation (S.D.) of failure loads (in Newtons) were 765 +/- 113/265 N, 790+/- 95/34 N, 614+/- 105/32 N for glass-fiber, ceramic and metallic groups, respectively. ANOVA test detected statistically significant differences between all groups. Teeth restored with fiber and ceramic posts exhibited significantly higher resistance to fracture than with titanium posts. Teeth restored by fiber and ceramic posts were statistically similar by LSD test. The highest proportion of undesirable fractures was seen with titanium posts. **Conclusion:** Usage of fiber and ceramic posts are preferable to titanium posts. Because of more undesirable fractures in the ceramic group than fiber group, use of the latter posts are recommended overall.

*Antonson, S.A., Yilmaz, Z., Kilinc, E., Antonson, D.E,, Hardigan, P. **Fracture resistance of endodontically treated lower incisors with fiber posts.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 1912, 2009. (www.dentalresearch.org)*

Objectives: To compare the effects of four fiber post systems with three luting cements on the fracture strength of endodontically treated and crowned lower anterior teeth. **Methods:** The root canals of 104 lower incisors were prepared to a #40 size. Roots covered in adhesive-tape to simulate PDL were mounted in acrylic-resin. Post spaces were prepared at 9mm leaving 5mm apical gutta-percha. Samples were divided into 12 study groups including four fiber post systems(Parapost Taperlux/ColteneWhaledent; D.T.Light-Post (RTD, St Egreve, France / Bisco); PeerlessPost/SybronEndo; **SpirapostPFS/ZenithDental**) and three cements(RelyX-Unicem/3MESPE; Nexus2-Dual-cure/Kerr; DualSyringe/Bisco). Control group included gutta-percha without posts. All teeth were restored(Parapost Paracore dual-cure-corematerial) and prepared in standard manner(4mm core-height, 1.2mm chamfer-finishline, 2mm ferrule). Base-metal full crowns including labial-step design(1x1mm) were fabricated and cemented with respective cements. Samples were statically loaded(Instron, 0.5mm crosshead-speed,18°angle on labial-step) until failure. Failure load(N) was statistically analyzed using One-way ANOVA with Tukey'sHSD. Samples were ranked by $\chi 2$ test for independence for the type of failure(catastrophic/favorable). Results: No differences were found between post or cement groups ($p>0.05$). Type of failure was not significant in any particular group. **Conclusions:** The different fiber posts with various cements performed similarly both in fracture toughness and failure mode, having the control group performing the best. Inclusion of ferrule may have an effect on the comparable results. Materials were supplied by respective companies.

Arksornnukit,M., Jiangkongkho, P., Chaijareenont, P. Srisunakrua, L., Takahashi, H. **Modulus of post affects fracture resistance of endodontically treated tooth.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2189, 2010 (www.dentalresearch.org)*

Objectives: Fiber reinforced post restored endodontically treated tooth (ETT) was considered as the monobloc configuration. The purpose of this study was to evaluate the different modulus of post on fracture resistance of ETT. **Methods**: Twenty four mandibular extracted premolars were decoronated at CEJ and endodontically treated. The root was filled with gutta percha and Grossman formula sealer using lateral condensation technique. Post space of 10.5 mm was performed using gate gridden drill and final enlarged with cylindrical bur with diameter 1.5 mm. The specimens were randomly divided into 4 groups with n=6. Three experimental fiber reinforced posts with glass fiber volume content of 0(E3, E=3GPa), 20 (E17, E=17GPa) and 40 (E31, E=31GPa) % and Ag-In alloy (E70, E= 70GPa) post were used as post. All types of post have parallel configuration with the same diameter of 1.5 mm. All posts were luted into the post space using Panavia F 2.0 as per manufacturer's recommendations. The SE bond was used as bonding agent for coronal part of the specimen and later built up using Clearfil Photocore (E=17GPa). Specimens were stored in 37°C water 24 hours prior to the test. The specimens were loaded at 45° on the buccal cusp using a universal testing machine (Instron 8872) with a cross head speed of 2 mm/min. The load in Newton (N) of all specimens were analyzed using one way ANOVA and Tukey's multiple comparison at $p<0.05$. **Results:** Means (sd) of fracture resistance were 1126.4(378.8), 952.44(169.5), 857.68(230.8) and 566.7(174.8) N for E17, E31, E70 and E3 respectively. Tukey's revealed that fracture resistance of E17 group was significantly greater than E3 group. **Conclusion:** Fiber reinforced composite post (E17) which has modulus close to core built up material and dentin demonstrated greater fracture resistance. Mode of failure of this group was restorable.

*Ayad, MF, Bahannan, SA, Rosenstiel, SF. **Fracture resistance of structurally compromised roots with aesthetic dowel systems** *J Dent Res.87 (Special Issue A) AADR Abstract #1036; 2008 (www.dentalresearch.org)*

Objectives: This study evaluated the validity of composite resin and glass ionomer cement for reinforcement of flared root canals before aesthetic dowel system application. **Methods:** To simulate weakness, the entire surfaces of 140 extracted human single-rooted teeth were enlarged to reduce the thickness of dentin wall to 0.5 mm. The teeth were equally divided into 7 test groups (n=20) according to the canal irrigant used: no irrigant (control), 5% hydrogen peroxide, 5% sodium hypochlorite, a combination of 5% hydrogen peroxide and sodium hypochlorite, 15% ethylenediaminotetraacetic acid (EDTA), 10% lactic acid, or 20% lactic acid. Within each group, half of treated root canals (n=10) were filled with composite resin (PermaFlo, Kerr) and the other half were filled with glass ionomer (Fuji One, GC America). A light-transmitting plastic post (Luminex, Dentatus) was used to create space for the fiber-reinforced posts (D.T. Light-Post, RTD, St Egreve, France/ Bisco) and (Aestheti-Post, (RTD, St Egreve, France/ Bisco) (n=5) and to cure the restorative materials All posts were cemented with adhesive resin cement (Panavia 21, Kurrary). Compressive load was applied at 130¨¬ on lingual surface of the composite core (Corestore 2, Kerr) to obtain the fracture resistance on an Instron universal testing machine. The data were analyzed with 1-way ANOVA followed by Ryan-Einot-Gabriel-Welsch Multiple Range Test (a=.05). **Results:** Lactic acid solutions and EDTA created micromechanical retention in the dentin with composite resin. Moreover, a hybrid layer was detected along the dentin wall and fracture resistance was significantly higher than other groups (p<.001). **Conclusions:** Composite resin bonding systems are an efficient method to reinforce structurally compromised roots with a lactic acid irrigant. Moreover, aesthetics can be enhanced with aesthetic dowel rehabilitation.

Balkaya MC, Birdal, IS**. Effect of resin-based materials on fracture resistance of endodontically treated thin-walled teeth**. *J Prosthet Dent. 2013 May;109(5):296-303. doi: 10.1016/S0022-3913(13)60304-2.*

Composite resins are recommended for root reinforcement, but little information exists about self-adhesive resin cements that eliminate the acid etching and bonding steps. **Purpose**: The purpose of this study was to compare the fracture resistances of teeth restored with 2 different diameters of cast and fiber posts and to evaluate the effectiveness of increasing internal root thickness with 2 resin-based materials to reinforce thin-walled teeth. **Methods:** Ninety maxillary incisors were endodontically treated and divided into 9 groups. In the first 4 groups, teeth were restored with tapered end cast (C1.3 and C1.7) and fiber (F1.3 and F1.7) posts of 1.3 and 1.7 mm diameters. In the other 5 groups, the root canals were enlarged to simulate the thin-walled teeth and restored with low viscosity composite resin with fiber posts of 1.3 and 1.7 mm diameters (LF1.3 and LF1.7), self-adhesive resin cement with fiber posts of 1.3 and 1.7 mm diameters (SF1.3 and SF1.7), and cast posts of 4 mm diameter that fit in post spaces (C4). Teeth were loaded to fracture at a 135-degree angle to their long axis. Data were analyzed with 2-way ANOVA and the Tukey HSD test (α=.05). **Results:** Significant difference (P<.001) existed between the fracture resistances of the teeth restored with cast (C1.3, 588.4 ±72.7 N) and fiber (F1.3, 375.3 ±53.8 N) posts of 1.3 mm diameter; however, no significant difference was found between 1.3 and 1.7 mm post diameters. The teeth restored with the resin-based materials with fiber posts, groups SF1.3 (331.6 ±135.2 N), SF1.7 (535.7 ±134.4 N), LF1.3 (432.1 ±120.3 N) and LF1.7 (563.8 ±128.8 N), demonstrated fracture resistance values similar to or higher than those of the teeth restored with the fiber posts, groups F1.3 (375.3 ±53.8 N) and F1.7 (461.8 ±98.4 N). The parallel-sided cast posts C4 (799.8 ±228.9 N) of 4 mm diameter demonstrated the highest fracture resistance of all groups (P<.001). **Conclusions:** The fracture resistance of the teeth increased as the elastic modulus of the posts increased but was not affected by small diameter variations of the posts. The resin-based materials were able to preserve and reinforce the remaining tooth structures.

Bandeca, M.C., El-Mowafy, O, Lima, J.P.M., Nadalin, M.R., Saade, E., Boaventura, J.M.C. Rastelli, A.N.S., Porto-Neto, S.T. **Fracture resistance of endodontically treated teeth after using intracoronal bleaching**. *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 610, 2009. (www.dentalresearch.org)*

Objectives: The aim of this study was to evaluate the fracture resistance and failure pattern of endodontically treated teeth after intracoronal bleaching with 35% hydrogen peroxide for 3 weeks with application of different restorative procedures. **Methods:** This study was performed on 80 mandibular incisors (n=80) and divided in 10 groups: G1: non-bleached teeth and restored with composite resin; G2: non-bleached teeth and luting of fiber-reinforced composite post (Everstick¨ Post, Sticktech) with Panavia¨ F 2.0 (Kuraray); G3: non-bleached teeth and luting of fiber-reinforced composite post with Breeze¨ (Pentral Clinical); G4: non-bleached teeth and luting of fiber glass post (Exacto¨, Angelus) with Panavia¨ F 2.0; G5: non-bleached teeth and luting of fiber glass post with Breeze; The groups G6 to G10 were the same materials of the anterior groups respectively, however the teeth were bleached. After 7 days storage in artificial saliva, the specimens were submitted to the fracture resistance test (kN) by a universal testing machine (Instron 4444) set at a speed of 0.5 mm/min and the data were submitted to the Tukey-Kramer multiple comparisons test. **Results:** No significant difference (p<0.05) was found between groups G1 to G10. The results suggest that intracoronal bleaching with 35% hydrogen peroxide did not significantly weaken the teeth. **Conclusion:** Among the application of different restorative procedures, the teeth restored with composite resin showed same values of resistance with those restored with non-metallic posts, however the failure pattern were predominately favorable to teeth restored with non-metallic posts.

Borelli, B, Sorrentino, R., Zarone, F, Ferrari, M. **Effect of the length of glass fiber posts on the fracture resistance of restored maxillary central incisors.** *Am J Dent. 2012 Apr;25(2):79-83.*

Purpose: To evaluate the influence of post length insertion on the fracture resistance of directly restored endodontically treated teeth. **Methods:** 30 maxillary central incisors were restored with glass fiber posts and composite cores to produce groups with post lengths of (1) 5 mm, (2) 7 mm, and (3) 9 m. Specimens were loaded at 130 degrees (Instron). Fracture strengths were analyzed with the Kolmogorov-Smirnov Test to verify the normality of the data distribution and with ANOVA and Tukey's post hoc test at $P < 0.05$. Fracture patterns (restorable or unrestorable) were analyzed (Pearson's Chi-square test). **Results:** The average fracture resistance was: Group 1 = 366.4 N, Group 2 = 507.4 N and Group 3 = 509.9 N. No significant difference was found among the three groups for fracture resistance or for failure mode. The insertion length did not influence the fracture pattern; more restorable fractures were detected.

Burmann, P, Cardoso, P., Santos, J, Soares, L. **Post Systems: compressive strength of roots prepared at 2/3 and ½ length restored with post systems**. *J Dent Res.81 IADR Abstract #1933; 2002 (www.dentalresearch.org)*

Objectives: Evaluate the mechanical resistance of roots restored with prefabricated posts. **Methods:** 40 sound upper human central incisors had the crown removed and the roots were endodontically treated. After 24 hours, the root canals were prepared using low rotation, going 2/3 or ½ down the depth of the root, and were divided into 4 groups (n=10). Group A: 10 roots were prepared on 2/3 of the depth for the cementation of the Unimetric Post (Dentsply/Maillifer) (**UNI**) using Clearfil LinerBond 2V and Panavia F (Kuraray Co. Japan), according to manufacturers instructions; Group B: 10 roots were prepared ½ down into the root canal for cementation with the same system as Group A; Group C: 10 roots were prepared on 2/3 of the depth for the cementation of the Aestheti-Post (AES: RTD, St Egreve, France) /Bisco) using ALL-BOND 2 (Bisco) and Post Cement HI-X (Bisco); Group D: 10 roots were prepared ½ down into the root canal for cementation with the same system as Group C. Three mm of the post were left outside of the root canal, on the cervical portion, to allow the fixation of the core restoration with composite resin (Z250-3M/ESPE, USA). Simulating preparation for a crown. The specimens underwent compression at 45^0 on a universal testing machine, at a speed of 0.5 mm/min. until fracture. **Results:** The mean values of load obtained at fracture (Group A=93.4 Kgf, Group B=88.4 Kgf, Group C=95.7 Kgf, Group D=96.3 Kgf) were statistically tested using ANOVA two-way test. **Conclusions:** All groups showed statistically similar results ($p>0.05$).The different preparation depths of the root canals did not influence the results of the strength tests.

Cardoso, P.C., Burmann, P.A., Silveira, B., Albers, A, Soares, L.F. **Fracture strength of bovine pulpless teeth restored by post systems**. *J Dent Res. 80; AADR Abstract # 227; 2001 (www.dentalresearch.org)*

The development of adhesive cements and prefabricated post system (PPS) provides us a conservative alternative to the traditional cast post –core in the reconstruction of endodontically treated teeth. However, the fracture strength of the core/tooth structures continues to be an object of doubts and discussions. The study aimed at evaluating the "in vitro" fracture strength of roots of restored inferior incisor bovine teeth. Thirty bovine teeth and ten human teeth were selected to constitute 4 groups (n=10); group 1) PPS Cosmopost (Ivoclar) + Syntac + Variolink II (Vivadent); group 2) PPS C-Post + All Bond 2 + Post Cement HI-X (Bisco, Inc., USA); group 3) PPS Aestheti-Post +All Bond 2 + Post Cement HI-X (Bisco, Inc., USA); and the group 4) (control group) human incisor teeth prepared for metal ceramic crown. The roots all the same length (15 mm), were embedded into acrylic resin blocks with a film (0.2 mm) of vinyl polysiloxane to simulate the periodontal ligament. The core was build up with composite (7.250 – 3M USA) through a custom transplant matrix. After 24 hours storage (H_20/37ºC) the specimens were submitted to the comprehensive test in Richie universal testing machine. The statistical analysis of the data (ANOVA) revealed no significant difference ($p>0.05$) among the fracture strength averages of the four groups. The values obtained from the pre-fabricated post systems gave us results are similar to those obtained with natural teeth.

Chuang, S-F, Yaman, P., Dennison, J., et al, **Fracture resistance of devitalized teeth restored with different prefabricated posts.** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #2926, 2005 (www.dentalresearch.org).*

Objectives: To investigate the fracture characteristics of devitalized teeth restored with posts of different materials and length. **Methods:** Sixty intact extracted incisors of similar size were chosen and sectioned 2mm coronal to the CEJ. The root canals were instrumented and obturated. Three different post systems were tested: stainless steel post (SB), glass-fiber post (GF), and carbon-fiber post (CF). The teeth were prepared to post lengths of 5 and 10 mm with the appropriate reamers for each post system. Composite cores of a standardized size were constructed over the cemented posts and Ni-Cr ceramic crowns were fabricated with a 1.5 mm ferrule length. The teeth were stored for 24 hours, thermocycled 1500 times (5-55¢XC). The tooth-crown assembly was mounted with a jig in a universal Instron testing machine and loaded at a crosshead speed of 0.5 mm/minute until failure. The teeth were then inspected under a stereoscope and SEM for fracture patterns. **Results:** The 10 mm/SB group had the lowest failure load (930 N), and was significantly different from the 5 mm/SB (1339 N) and 10 mm/GF group (1271 N). There was no significant difference in the failure loads among the fiber post groups, and in the failure toughness among six groups. Oblique fracture was the dominant pattern in all groups. Teeth restored with posts of the same material demonstrated similar fracture location and directions. Under SEM observation, cracked dentinal tubules were found in the lingual aspects of the SB posts. Over half of the specimens in the metal post groups exhibited fracture planes passing through the apex of the post. **Conclusions:** Use of a 10 mm

metal post did not improve the fracture strength of the restored devitalized teeth. Fiber posts provide more uniform stress distribution, which may prevent fracture at the apical end of the post. The fracture patterns of the teeth were associated with the post materials, while the post length had little influence on either the fracture strength or patterns of the teeth.

Chuang , SF, Yaman, P., Herrero, A., Dennison, JB., Chang. C-H. **Influence of post material and length on endodontically treated incisors: An in vitro and finite element study.** *The Journal of Prosthetic Dentistry. Volume 104, Issue 6, December 2010, Pages 379-388.*

Statement of problem: Cast posts require sufficient length for prosthesis retention and root strength. For prefabricated metal and fiber posts, the effects of different post lengths on the strength and internal stress of the surrounding root need evaluation. **Purpose:** The purpose of this study was to examine, using both experimental and finite element (FE) approaches, the influence of post material and length on the mechanical response of endodontically treated teeth. **Methods:** Sixty extracted incisors were endodontically treated and then restored with 1 of 3 prefabricated posts: stainless steel (SS), carbon fiber (CF), and glass fiber (GF), with intraradicular lengths of either 5 or 10 mm (n=10). After composite resin core and crown restorations, these teeth were thermal cycled and then loaded to fracture in an oblique direction. Statistical analysis was performed for the effects of post material and length on failure loads using 2-way ANOVA (α=.05). In addition, corresponding FE models of an incisor restored with a post were developed to examine mechanical responses. The simulated tooth was loaded with a 100-N oblique force to analyze the stress in the root dentin. **Results;** The SS/5 mm and all fiber post groups presented no statistical differences, with mean (SD) fracture loads of 1247 to 1339 (53 to 121) N. The SS/10 mm group exhibited a lower fracture load, 973 (115) N, and a higher incidence of unfavorable root fracture ($P<.05$). The FE analysis showed high stress around the apical end of the long SS post, while stress was concentrated around the crown margins in the fiber post groups. **Conclusions**: Both long and short fiber posts provided root fracture resistance comparable to that of SS posts. For metal posts, extending the post length does not effectively prevent root fracture in restored teeth. **PDF**

da Silva, NR, Raposo, LH, Versluis, A, Fernandes-Neto, AJ, Soares, CJ. **The effect of post, core, crown type, and ferrule presence on the biomechanical behavior of endodontically treated bovine anterior teeth**. *J Prosthet Dent. 2010 Nov;104(5):306-17.*

Statement of problem: Unresolved controversy exists concerning the remaining coronal tooth structure of anterior endodontically treated teeth and the best treatment option for restoring them. **Purpose:** The purpose of this study was to evaluate the effect of post, core, crown type, and ferrule presence on the deformation, fracture resistance, and fracture mode of endodontically treated bovine incisors. **Methods:** One hundred and eighty bovine incisors were selected and divided into 12 treatment groups (n=15). The treatment variations were: with or without ferrule, restored with cast post and core, glass fiber post with composite resin core, or glass fiber post with fiber-reinforced core, and metal- or alumina-reinforced ceramic crown (n=15). The restored incisors were loaded at a 135-degree angle, and the deformation was measured using strain gauges placed on the buccal and proximal root surfaces. Specimens were subsequently loaded to the point of fracture. Strain and fracture resistance results were analyzed by 3-way ANOVA and Tukey HSD tests (α=.05). **Results:** Ferrule presence did not significantly influence the buccal strain and fracture resistance for the ceramic crown groups, irrespective of core and crown type. Ferrule presence resulted in lower strains and higher fracture resistance in the metal crown groups, irrespective of core. The cast post and core showed lower strain values than groups with glass fiber posts when restored with metal crowns. **Conclusions:** Core type did not affect the deformation and fracture resistance of endodontically treated incisors restored with alumina-reinforced ceramic crowns. The presence of a ferrule improved the mechanical behavior of teeth restored with metal crowns, irrespective of core type.

D'Arcangelo, C, De Angelis, F, Vadini, M, Zazzeroni, S, Ciampoli, C, D'Amario, M. **In vitro fracture resistance and deflection of pulpless teeth restored with fiber posts and prepared for veneers.** *J Endod. 2008 Jul;34(7):838-41. Epub 2008 May 16.*

The aim of this in vitro study was to evaluate the influence of endodontic therapy, veneer preparation, and their association on fracture resistance and deflection of pulpless anterior teeth and assess whether restoration with quartz fiber-reinforced post can influence these properties. Seventy-five freshly extracted human maxillary central incisors were selected. Teeth were randomly divided into 4 experimental groups (veneer preparation/endodontic therapy/endodontic therapy and veneer preparation/endodontic therapy, veneer preparation, and fiber post placement) and a control group (n = 15). Specimens were loaded to fracture recording crown deflection under load, and data were statistically analyzed. Veneer preparations and endodontic treatment did not significantly influence fracture resistance of maxillary incisors. On the contrary, preparation for veneer significantly increased the deflection values of the specimens. Fiber post restorations seemed to significantly increase mean maximum load values for specimens prepared for veneers. A fiber-reinforced post restoration can be suggested when endodontic treatment is associated with veneer preparation. **PDF**

D'Arcangelo C, De Angelis F, Vadini M, D'Amario M, Caputi S**. Fracture resistance and deflection of pulpless anterior teeth restored with composite or porcelain veneers.** *J Endod. 2010 Jan;36(1):153-6.*

Introduction: The aim of this in vitro study was to evaluate the influence that resin composite and porcelain veneer restorations, associated or not to fiber post placement, have on fracture resistance and deflection of pulpless anterior teeth. **Methods:** One hundred twenty freshly extracted human maxillary central incisors were selected. Teeth were randomly divided into 7 experimental groups (veneer preparation/resin composite veneer placement/endodontic therapy and resin composite veneer placement/endodontic therapy, fiber post and resin composite veneer placement/porcelain veneer placement/endodontic therapy and porcelain veneer placement/endodontic therapy, fiber post and porcelain veneer placement) and a control group (n = 15). Specimens were loaded to fracture recording crown deflection, and data were statistically analyzed. **Results:** Veneer preparations did not significantly influence fracture resistance of incisors. On the contrary, veneer preparation significantly increased specimen deflection values. Fiber posts seemed to significantly increase mean maximum load values for endodontically treated teeth restored with either composite or porcelain veneers. C**onclusions**: A fiber post restoration can be suggested when endodontic treatment is associated with veneer restoration. Veneer restorations seem to be an optimal choice also for endodontically treated teeth. **PDF**

de Oliveira, JA, Pereira, JR, Lins do Valle, A, Zogheib, LV. **Fracture resistance of endodontically treated teeth with different heights of crown ferrule restored with prefabricated carbon fiber post and composite resin core by intermittent loading.** *Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008 Nov;106(5):e52-7. Epub 2008 Aug 20.*

This study evaluated the fracture resistance of endodontically treated teeth restored with prefabricated carbon fiber posts and varying quantities of coronal dentin. Sixty freshly extracted upper canines were randomly divided into groups of 10 teeth each. The specimens were exposed to 250,000 cycles in a controlled chewing simulator. All intact specimens were subjected to a static load (N) in a universal testing machine at 45 degrees to the long axis. Data were analyzed by 1-way analysis of variance and Tukey test (alpha = .05). Significant differences ($P < .001$) were found among the mean fracture forces of the test groups (positive control, 0 mm,1 mm, 2 mm, 3 mm, and negative control groups: 1022.82 N, 1008.22 N, 1292.52 N, 1289.19 N, 1255.38 N, and 1582.11, respectively). These results suggested that the amount of coronal dentin did not significantly increase the fracture resistance of endodontically treated teeth restored with prefabricated carbon fiber post and composite resin core. **PDF**

Dean, J. P., Jeansonne, B. G., and Sarkar, N. **In vitro evaluation of a carbon fiber post.** *Journal of Endodontics. 24: 807-810, 1998.*

Abstract/conclusions: The purpose of this study was to evaluate the influence of endodontic and restorative procedures on fracture resistance of teeth, and to compare the incidence of root fracture in teeth with clinical crowns removed that were restored with three different types of post and a composite core build-up. Seven groups of 10 extracted maxillary canines were used. A control group had only a crown preparation, but no endodontic treatment. Three groups had endodontic treatment, crown preparation, and the access restored. Three groups had endodontic treatment, the crown totally removed, a tapered, parallel, or carbon post (Composipost) placed, and a composite build-up. All specimens were subjected to a 45-degree load at 0.5 mm/min until failure occurred. The force at failure and the location of fracture were recorded. The groups with post and composite build-ups failed at significantly lower force than the teeth in which the crowns had not been removed. There were no significant differences in the amount of force required to produce failure among the three groups with different posts and a composite build-up. The group restored with the Composipost had no root fractures, whereas there were five fractures (50%) in each of the parallel and tapered post groups. **PDF**

Dietschi, D, Ardu, S, Rossier-Gerber, A, Krejci, I. **Adaptation of adhesive post and cores to dentin after in vitro occlusal loading: evaluation of post material influence.** *J Adhes Dent. 2006 Dec;8(6):409-19*

Purpose: Fatigue resistance of post and cores is critical to the long term behavior of restored nonvital teeth. The purpose of this in vitro trial was to evaluate the influence of the post material's physical properties on the adaptation of adhesive post and core restorations after cyclic mechanical loading. **Methods:** Composite post and cores were made on endodontically treated deciduous bovine teeth using 3 anisotropic posts (made of carbon, quartz, or quartz-and-carbon fibers) and 3 isotropic posts (zirconium, stainless steel, titanium). Specimens were submitted to 3 successive loading phases--250,000 cycles at 50 N, 250,000 at 75 N, and 500,000 at 100 N--at a rate of 1.5 Hz. Restoration adaptation was evaluated under SEM, before and during loading (margins) and after test completion (margins and internal interfaces). Six additional samples were fabricated for the characterization of interface micromorphology using confocal microscopy. **Results:** Mechanical loading increased the proportion of marginal gaps in all groups; carbon fiber posts presented the lowest final gap proportion (7.11%) compared to other stiffer metal-ceramic or softer fiber posts (11.0% to 19.1%). For internal adaptation, proportions of debonding between dentin and core or cement varied from 21.69% (carbon post) to 47.37% (stainless steel post). Debonding at the post-cement interface occurred only with isotropic materials. Confocal microscopy observation revealed that gaps were generally associated with an incomplete hybrid layer and reduced resin tags. **Conclusions:** Regardless of their rigidity, metal and ceramic isotropic posts proved less effective than fiber posts at stabilizing the post and core structure in the absence of the ferrule effect, due to the development of more interfacial defects with either composite or dentin. **PDF**

Dikbas, I, Tanalp, J, Ozel, E, Koksal, T, Ersoy, M. **Evaluation of the effect of different ferrule designs on the fracture resistance of endodontically treated maxillary central incisors incorporating fiber posts, composite cores and crown restorations.** *J Contemp Dent Pract. 2007 Nov 1;8(7):62-9.*

Aim: The purpose of this study was to evaluate the fracture resistance of endodontically treated maxillary central incisors restored with quartz fiber posts, composite cores, and crowns when different types of ferrule designs were incorporated. **Methods:** Sixty maxillary incisors were divided into six groups: Group 1 (control): teeth with root canal treatments having a full crown prosthesis; Group 2: teeth with a 2 mm circumferential ferrule; Group 3: teeth with a 2 mm ferrule only in the vestibular region; Group 4: teeth with a 2 mm ferrule only in the palatal region; Group 5: teeth with a 2 mm ferrule in the vestibular and palatal region, having cavities in both proximal areas; and Group 6: teeth with no ferrule. The teeth in the experimental groups were restored with quartz fiber posts-composite cores and full metallic crowns. All experimental teeth were subjected to an increasing compressive force with a crosshead speed of 1 mm/min, until fracture occurred. **Results:** The median fracture values of groups were as follows: Group 1: 574.4 N, Group 2: 472.4 N, Group 3: 474.3 N, Group 4: 480.7 N, Group 5: 463.1 N, and Group 6: 297.9 N. A statistically significant difference was found between Group 1 and Group 6 ($p < 0.01$). **Conclusions:** It was concluded different ferrule designs did not have any influence on the fracture resistance of teeth with fiber posts. The results of this study indicate fiber posts can safely be used for their reinforcing properties. Furthermore, there is no significant change in the resistance of teeth with fiber posts regardless of which ferrule design is incorporated. The property of these types of posts is an additional advantage in clinical practice. **PDF**

Dikbas I, Tanalp J, Koksal T, Yalnız A, Güngör T. **Investigation of the effect of different prefabricated intracanal posts on fracture resistance of simulated immature teeth**. *Dent Traumatol. 2013 Feb 4. doi: 10.1111/edt.12034. [Epub ahead of print]*

Aim: The aim of this study was to assess fracture resistances of simulated immature single-rooted teeth whose roots have been backfilled using 3 different post systems after a 4 mm apical mineral trioxide aggregate (MTA) placement. METHODS: Forty-eight maxillary anterior teeth were assigned into four groups. The lengths of each root were standardized by cutting off the coronal and apical portions to obtain 13 ± 1 mm samples and root canals were enlarged. The #6 Peeso reamers were allowed to protrude 1 mm beyond apex to simulate immature teeth. Apical 4 mm of each tooth was filled using MTA. The remaining portions were treated as follows: Group 1 (Control): AH Plus + Gutta-percha cold lateral compaction. Group 2: Glass fiber posts (FRC Postec Plus post) cemented using self-adhesive resin cement. Group 3: Quartz fiber posts (D.T. Light post) cemented using self-adhesive resin cement. Group 4: Zirconia posts (Cosmopost) were placed using self-adhesive resin cement. Specimens were embedded in self-curing acrylic. A compressive load was applied lingually at a crosshead speed of 1 mm/min at an angle of 45º until fracture in a universal testing machine. RESULTS: The mean fracture resistances were 823.17 ± 188.80, 1155.50 ± 190.37, 1208.00 ± 254.32, and 1153.25 ± 195.71 Newtons for Groups 1, 2, 3, and 4, respectively. All experimental groups had significantly higher fracture resistance compared with the control group ($P < 0.01$). No statistically significant difference was noted between the experimental groups ($P > 0.05$). CONCLUSIONS: All post systems exerted a similar reinforcing effect to a simulated immature tooth and may be preferred specifically in situations which require additional reinforcement.

El Guindy, J, Fouda, MY. **Effect of obturating systems, dowel materials, and adhesive luting techniques on the resistance to fracture of endodontically treated teeth.** *J Prosthodont. 2010 Oct;19(7):544-52. doi: 10.1111/j.1532-849X.2010.00636.x. Epub 2010 Aug 16*

Purpose: The aim of this study was to assess the role of obturating systems, dowel materials, and adhesive techniques on the resistance to fracture of endodontically treated teeth. **Methods:** Eighty maxillary central incisors were selected and randomly divided into two groups according to the obturatingsystem (n = 40); group I: gutta-percha and Roeko sealer; group II: RealSeal. Both groups were further subdivided into two subgroups; subgroup A: using ceramic dowels (Cosmopost); subgroup B using fiber dowels (Easy Post). Each subgroup was assigned to two divisions according to the adhesive luting technique; division V (total-etch) Variolink II resin cement; division U (self-adhesive) RelyX Unicem. Composite core build-up was made using a core former. Each specimen was loaded 2 mm from its incisal edge on the palatal side at a 135° angle with the long axis of the tooth using a universal testing machine with a load cell of 5 KN at a crosshead speed of 0.5 mm/min until fracture. Failure loads were recorded in N. Scanning electron microscopic examination at the dentin/resin interface (1000x) was performed. Three-way ANOVA was used to test the effect of obturating system, dowel material, adhesive technique, and their interactions (obturating system * dowel material, obturating system * adhesive, dowel material * adhesive, obturating system * dowel material * adhesive). Duncan's test was used for pairwise comparison. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with SPSS 16.0. **Results:** The mean resistance to fracture (617.4 N) was statistically significantly higher in the ceramic dowel with gutta-percha and Variolink (GP/C/V) group than in the other groups. The RealSeal and RelyX fiber dowel group's mean resistance was the lowest and was significantly lower than the other groups. **Conclusions:** In this study, three factors played a part in enhancing the resistance to fracture of endodontically treated teeth. High resistance to fracture was achieved when ceramic dowels were luted with total-etch technique in gutta-percha-obturated teeth.

*Fathi, M., Mortazavi, MV, Katiraie, N. **Fracture resistance of endodontically treated teeth restored with esthetic posts.** *J Dent Res.Vol 87 (Spec Iss A) Abstract #1857, 2008 (www.dentalresearch.org)*

Objectives: This study compared the effect of three esthetic post systems with different modulus of elasticity on the fracture resistance and fracture patterns of endodontically treated teeth with structurally compromised and normal roots. **Methods**: Forty five extracted and root canal treated central incisors were assigned to 2 main experimental groups called "narrow" and "flared" canals. Narrow-canal group divided into 2 and flared-canal group, divided into 3 experimental subgroups (n=9). For narrow-canal subgroups, post spaces were prepared with the corresponding drills to restore with quartz fiber double taper light posts (D.T. Light-Post; RTD St Egreve, France) [subgroup A] and zirconia posts (CosmoPost;Ivoclar) [subgroup B]. For the flared-canal subgroups, thin–walled canals were simulated, and restored with quartz fiber double taper light posts[subgroup C], quartz fiber double taper light posts inserted within the polyethylene woven fibers (Ribbond; Ribbond,Inc) [subgroup D] and zirconia posts[subgroup E]. All posts were cemented with dual–polymerizing adhesive resin cement (Panavia F; Kuraray).After restoration of access cavity with composite and thermocycling, compressive load was applied to the palatal surface of tooth until fracture. Mean failure load values were analyzed using One-way ANOVA and Tukey test (P<0.05).Mode of failure was evaluated with Fisher exact test (P<0.05). **Results:** The mean failure loads ± SD were 678.55±90.86, 603.44±68.66, 638.22±93.71, 732.44±81.78, and 573.66±91.340 N for subgroups A to E, respectively. Subgroup D exhibited significantly higher resistance to fracture compared to subgroups B, C and E (P<0.05). Subgroup E showed significantly less fracture resistance compared to subgroups A and D (P<0.05). Subgroups B and E showed more root fracture compared to subgroups A, C, and D (P=0,004). **Conclusion:** Significantly higher fracture resistance was observed in flared root canal treated teeth restored with quartz fiber double taper light posts + polyethylene woven fibers. Zirconia posts showed lower fracture resistance and significantly more root fracture compared to fiber posts.

Fellippe, L. A., Monteiro, S. et al**. Influence of the use and type of endo posts used in the cervical stress level of central incisors submitted to the fatigue test; an in vitro study.** *J Dent Res. Vol 81 (Spec. Iss. A) Abstract #0057, 2002**. (www.dentalresearch.org)*

Objectives: The objective of this study was to observe the biomimetic behavior of the fiber resin post and cast post in the cervical stress level of central incisors submitted to the fatigue test. A group of non-posted tooth was also evaluated. **Methods:** Thirty six recently extracted upper central incisors were selected. The teeth were divided in three groups. G1 – Cast post and core. G2 – Fiber resin post and composite core G3 – without post and core. Post was introduced 2/3 of the root. All groups were endodontically treated and received a full cast crown. G1 e G2 were cut 1mm to the cervical limit. G3 was just restored with composite resin. For the fatigue test, the teeth were mounted in epoxy supports with a simulation of the periodontal ligament. The angle of test was 45º . An Instron 4444 (Universal Test Machine) was used for the compressive fatigue test. The maximum load was 60N. After the fatigue test, the groups were thermocycled and immersed in ethylene blue die for 24 hrs. **Results:** were obtained after teeth sectioning. The Kruskal-Wallis test was used. The average for each group was G1-3.0, G2-1.7, G3-4.6. A significant difference was observed (p<0,05) (T=16.25 and p=0,0003.) G2 had the best result. **Conclusion:** the study suggests that teeth with fiber resin post better resists the fatigue test than teeth with cast post or without post, under the specific conditions of the study.

Forberger, N, Göhring TN. **Influence of the type of post and core on in vitro marginal continuity, fracture resistance, and fracture mode of lithia disilicate-based all-ceramic crowns.** *J Prosthet Dent. 2008 Oct;100(4):264-73*

Statement of problem: The influence of different crown foundations on marginal seal and fracture resistance of ceramic crowns placed on endodontically treated teeth has not been clearly established. **Purpose:** The purpose of this study was to evaluate the marginal continuity and fracture behavior of high-strength all-ceramic crowns with different substructures in endodontically treated premolars. **Methods:** Forty-eight human mandibular premolars were assigned to 6 groups, including a no-treatment group (Untreated) and a group for which the access cavity was restored with composite resin (Tetric Ceram) (COMP). In the remaining 4 groups, teeth were prepared to receive all-ceramic crowns with 0.8-mm-wide shoulders and axial dentin heights of 2 mm. No posts were used in the Endocrown group. Glass fiber posts (FRC Postec) were used in group FRC-POST. Group ZRO-POST received zirconia ceramic posts (CosmoPost), and group GOLD-POST received cast gold posts (CM). Experimental lithia disilicate ceramic crowns were made and adhesively cemented (Variolink). All teeth were subjected to thermal cycling and mechanical loading (TCML) in a masticatory simulator (1,200,000 loads, 49 N, 1.7 Hz, 3000 temperature cycles of 5 degrees C-50 degrees C-5 degrees C). Marginal continuity was evaluated with scanning electron microscopy at x200. All specimens were loaded to failure in a universal testing machine at 0.5 mm/min after TCML. Data were analyzed using 1-way ANOVA and post hoc t tests with Bonferroni correction (alpha=.05). **Results:** Initially, mean values (SD) between 72.4 (15.8)% (Endocrown) and 94.8 (3)% (FRC-POST) for continuous margins were found. With TCML, marginal continuity decreased significantly only in FRC-POST, to 75.5 (8.4)%, and in Endocrown, to 44.7 (14.5)%. Mechanical load testing measured mean loads to failure between 1092.4 (307.8) N (FRC-POST) and 1253.7 (226.5) N (ZRO-POST) without significant differences between groups. Deep root fractures were observed in half of the specimens, irrespective of their groups. **Conclusions:** Marginal continuity of the crowns studied was better and more stress resistant when posts and cores were included in the restoration of endodontically treated teeth with complete ceramic crowns. The placement of a post-and-core foundation did not influence the pattern of failure.

Giovani, A.R., Vansan, L.P., de Sousa Neto, M.D., Paulino, S.M. **In vitro fracture resistance of glass-fiber and cast metal posts with different lengths.** *J Prosthet Dent. 2009 Mar;101(3):183-8.*

Statement of problem: Dental fractures can occur in endodontically treated teeth restored with posts. **Purpose:** The purpose of this study was to evaluate the in vitro fracture resistance of roots with glass-fiber and metal posts of different lengths. **Methods:** Sixty endodontically treated maxillary canines were embedded in acrylic resin, except for 4 mm of the cervical area, after removing the clinical crowns. The post spaces were opened with a cylindrical bur at low speed attached to a surveyor, resulting in preparations with lengths of 6 mm (group 6 mm), 8 mm (group 8 mm), or 10 mm (group 10 mm). Each group was divided into 2 subgroups according to the post material: cast post and core or glass-fiber post (n=30). The posts were luted with dual-polymerizing resin cement (Panavia F). Cast posts and cores of Co-Cr (Resilient Plus) crowns were made and cemented with zinc phosphate. Specimens were subjected to increasing compressive load (N) until fracture. Data were analyzed with 2-way ANOVA and the Tukey-Kramer test (alpha =.05). **Results:** The ANOVA analysis indicated significant differences (P<.05) among the groups, and the Tukey test revealed no significant difference among the metal posts of 6-mm length (26.5 N +/-13.4), 8-mm length (25.2 N +/-13.9), and 10-mm length (17.1 N +/-5.2). Also, in the glass-fiber post group, there was no significant difference when posts of 8-mm length (13.4 N +/-11.0) were compared with the 6-mm (6.9 N +/-4.6) and 10-mm (31.7 N +/-13.1) groups. The 10-mm-long post displayed superior fracture resistance, and the 6-mm-long post showed significantly lower mean values (P<.001). **Conclusions:** Within the limitations of this study, it was concluded that the glass-fiber post represents a viable alternative to the cast metal post, increasing the resistance to fracture of endodontically treated canines. **PDF**

Giovani, A.R. , Pasqualin, F.H., Rodrigues' L.M., Souza-Filho, ' C.B., Sousa-Neto, M.D., Silva-Sousa, Y.T.C., Paulino, S.M., Vansan, L.P. **Fracture resistance of posts with different geometric configuration**. *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 608, 2009. (www.dentalresearch.org)*

Objectives: This study evaluated in vitro the fracture resistance of roots with metallic and glass-fiber intraradicular retainers, varying the geometric configuration and using the compression test. **Methods:** The sample had 50 central superior incisives: 10 received only the coronary preparation (control) and 40 had their crowns sectioned and radicular canals endodontically treated (experimental group). The roots were embedded in acrylic resin, except for the 4 mm of cervical area. The prosthetic space was performed with cylindrical bur in low speed attached to a parallelometer. Groups were then randomly divided: teeth only coronary prepared (I), metallic cast posts with cylindrical (II) and conical (III) shape, glass-fiber posts with cylindrical (IV) and conical (V) shape, which were luted with Panavia F. Metallic cast crowns made done and cemented with zinc phosphate. The resin/dentin blocks were positioned in the Instron 4444 Universal Machine, using a rectangular tip with round edge, in an angle of 135 in relation to the root long axis. **Results:** Means in KN were: I (0.87±0.23), II (0.44±0.24), III (0.57±0.19), IV (0.71±0.35), V (0.45±0.11). The Tukey test showed no significant difference (p>0.05) between the cylindrical and conical metallic posts. The cylindrical glass-fiber posts were statistically similar (p>0.05) to the control group, which presented the higher fracture resistance values. **Conclusions:** It was concluded that the geometric configuration influenced on the fracture resistance of glass-fiber posts.

Giovani, A., Souza Filho, C.B., Pasqualin, F. H., Vansan,L. P., Silva-Sousa, Y., Sousa-Neto, M., Alfredo, E., Paulino, S. M. **Fracture resistance of different characteristic posts: material, configurations and lengths.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2181, 2010 (www.dentalresearch.org)*

Objective: The purpose of this study was to evaluate the in vitro fracture resistance of roots with glass-fiber and metallic cast post varying the lengths and the geometric configuration, using the compression test. **Methods:** Eighty caries-free maxillary canines had their crowns sectioned and the radicular canals endodontically treated. The roots were embedded in acrylic resin, except for the 4 mm of cervical area. The specimens were divided into four groups: I - conical metallic cast posts (n= 20); II - cylindrical metallic cast posts (n= 20) III - glass-fiber tapered posts (n= 20) and IV - glass-fiber cylindrical posts (n= 20). Each group was divided into 2 subgroups according to the post length: A - 10 mm (n= 10) and B - 8 mm (n= 10) and the post spaces were opened with cylindrical and conical burs at low speed attached to a surveyor. Metallic cast crowns were made and cemented with zinc phosphate. The resin/dentin blocks were positioned in the Instron 4444 Universal Machine and using a rectangular tip with round edge, in an angle of 135o in relation to the root long axis, the specimens were subjected to increasing compressive load at a speed of 1 mm/min until fracture. **Results:** The ANOVA analysis indicated significant differences (p<.05) between post types: metal cast (0.66kN) and fiberglass (0.77kN) between the geometric configurations: cylindrical (0.80kN) and conical (0.62kN) and between the lengths: 10 mm (0.77kN) and 8 mm(0.65N. **Conclusions:** It was concluded that the different materials used in the composition of the posts and the different lengths and geometric configurations may interfere with the fracture resistance of roots.

*Hajizadeh, H., Namazikhah, MS, Moghaddas, MJ., Ghavmnasiri, M., Majidinia, S. **Effect of posts on the fracture resistance of load cycled endodontically treated premolars restored with direct composite resin.** *J Contemp Dent Pract Vol 10, No. 3, 2009 1-10*

Aim: The aim of this study was to investigate the fracture resistance and failure mode of premolars restored with composite resin using various prefabricated posts. **Methods:** Sixty sound maxillary premolars were divided into four equal sized groups. All but the control group reveived endodontic treatment followed by placement of MOD composite restorations (Tetric Ceram; Ivoclar, Leichtenstein) as follows: Group T = no post, Group DT= fiber reinforced composite post (DT Light-Post, RTD, Grenoble, France), Group FL= prefabricated metal post (Filpost). The control group (C) had no cavity preparation. After thermal and load

cycling, static load was applied at 30 degrees' angle until fracture. Failure modes were categorized as restorable and non-restorable. Data were analyzed using the analysis of variance (ANOVA) and Duncan tests ($\alpha = 0.06$). **Results:** The mean value s of fracture loads (N) for all groups were: C (880 +/-258); T (691+/- 239); DT (865+/-269); and FL(388+/-167). Statistically significant differences ($P<0.05$) were observed for all groups except between groups C and DT. The Chi square test showed failure modesin Groups C and DT were mostly restorable. The most non-restorable fractures were observed in Group FT. **Clinical singnificance:** The results of this study suggest that a quartz fiber post used in conjunction with an MOD composite resin restoration inproves fracture resistance in an endodontically treated pre-molar. **PDF**

Hatta, M., Shinya, A, Vallittu, PK, Shinya, A., Lassila, VJ. **High volume individual fibre post *versus* low volume fibre post: The fracture load of the restored tooth.** *Journal of Dentistry Volume 39, Issue 1, January 2011, Pages 65–71*

Objectives: The purpose of this study was to evaluate the fracture loads of post-and-core systems with two different individually formed fibre post designs and polymerization conditions. **Methods:** Totally seventy-two (n = 8/group) bovine teeth were cut and made up the root length of 15.0 mm. They were divided into 3 main groups (Group A, B, C). A: one glass fibre post was light-cured before cementation, B: fibres were bundled to fill the entire root canal opening and light-cured before cementation, C: one unpolymerized glass fibre post was inserted into cement-filled root canal and light-cured with luting cement (ParaCem). Moreover specimens of each group were divided into 3 subgroups according to the post length: subgroup 1: 10 mm; subgroup 2: 7.5 mm; subgroup 3: 5.0 mm. After cementation, the core was built up, and then made the composite resin crown (Filtek Z250). Fabricated specimen was loaded from 45° of palatal side at a crosshead speed of 1.0 mm/min. The first load drop and maximum fracture loads were statistically analyzed by ANOVA and Tukey's test**. Results***:* Maximum fracture load of Group B (433 N) and C (418 N) are significantly higher than Group A (284 N) ($p < 0.01$). Short post (5 mm) provided higher fracture loads in all main groups, especially in Group C. **Conclusions***:* Using short and thick fibre post system (the same diameter as the root canal) showed higher strength than one fibre post only. In addition, by curing the cement and the fibre material simultaneously, the strength of the restored tooth was increased.

Hayashi, M., Takahashi, Y., Imazato, S., Ebisu, S. **Fracture resistance of pulpless teeth restored with post-cores and crowns**. *Dent Mater. 2005 Sep 16*

Objectives: The present study was designed to test the null hypothesis that there is no difference in the fracture resistance of pulpless teeth restored with different types of post-core systems and full coverage crowns. **Methods:** Extracted human upper premolars were restored with a fiber post, prefabricated metallic post or cast metallic post-core. Teeth with full crown preparations without post-core restorations served as a control. All teeth were restored with full coverage crowns. A 90-degree vertical or 45-degree oblique load was applied to the restored teeth with a crosshead speed of 0.5mm/min, and the fracture loads and mode of fracture were recorded. **Results:** Under the condition of vertical loading, the fracture load of teeth restored with the cast metallic post-cores was greatest among the groups (two-factor factorial ANOVA and Scheffe's F test, $P<0.05$). All fractures in teeth restored with all types of post-core systems propagated in the middle portions of roots, including the apices of the posts. Under the condition of oblique loading, the fracture load of teeth restored with pre-fabricated metallic posts was significantly smaller than that in other groups. Two-thirds of fractures in the fiber post group propagated within the cervical area, while most fractures in other groups extended beyond the middle of the roots. **Significance:** From the results of the present investigations, it was concluded that under the conditions of vertical and oblique loadings, the combination of a fiber post and composite resin core with a full cast crown is most protective of the remaining tooth structure.

Hayashi, M, Sugeta, A, Takahashi, Y, Imazato, S, Ebisu, S. **Static and fatigue fracture resistances of pulpless teeth restored with post-cores.** *Dent Mater. 2008 Sep;24(9):1178-86. Epub 2008 Mar 28*

Objective: Superior restorative methods for effectively strengthening pulpless teeth need to be identified, since vertical root fractures of pulpless teeth are still a major problem in everyday clinical practice. The present study tested the null hypothesis that there were no differences in static and fatigue fracture resistances of pulpless teeth restored with different types of post-core systems. **Methods:** Extracted human premolars were restored with a combination of either a fiber post or metallic post and a composite resin core. Teeth with full crown preparations without post-core restorations served as a control. A 90 degrees vertical or 45 degrees oblique static compressive load was applied to restored teeth, and fracture loads and modes of fracture were recorded. Fatigue fracture tests were conducted by applying sinusoidal cyclic loads to restored teeth from vertical or oblique directions. Fatigue limits for each restoration were calculated using the staircase approach. **Results:** In both static and fatigue fracture testing under vertical or oblique loadings, the fracture loads of teeth restored with fiber posts were significantly greater than those of teeth restored with metallic posts. The fatigue limits of teeth restored with fiber and metallic posts were 112 kgf and 82 kgf respectively under vertical loadings and 26 kgf and 20 kgf under oblique loadings. **Significance:** The combination of a fiber post and a composite resin core showed superior fracture resistance against both static and fatigue loadings compared to restorations using a metallic post, and is therefore recommended in restoring pulpless teeth. **PDF**

Isidor, F., Odman, P., and Brondum, K. **Intermittent loading of teeth restored using prefabricated carbon fiber posts.** *International Journal of Prosthodontics. 9: 131-136, 1996.*

Abstract/conclusions: This in vitro study evaluated the fracture resistance of bovine teeth with prefabricated carbon fiber posts (Composipost). Fourteen bovine teeth having similar lengths and dimensions were mounted in an acrylic resin block having a simulated periodontal ligament. The post space was prepared using two calibrated drills that provided an 8.5-mm post length. The prefabricated carbon fiber post was luted with a resin luting agent, and the core was made using the system's autopolymerizing resin core material. A crown was luted to each prepared tooth. Each test specimen was intermittently loaded (250 N) at an angulation of 45 degrees to the long axis of the tooth at a frequency of 2 loads per second. Four of the roots had an incomplete longitudinal fracture after loading. The results of this study were compared to a previous study by the authors that had been conducted under similar conditions. The failure rates of the two types of posts from the previous study (prefabricated parallel-sided posts (Para-Post) and tapered, individually cast posts) were significantly higher (Logrank test; $P<.02$) than those of the carbon fiber posts. **PDF**

* Kim, YH, Lee, JH. **Influence of modification in core building procedure on fracture strength and failure patterns of premolars restored with fiber post and composite core**. *J Adv Prosthodont. 2012 Feb;4(1):37-42. Epub 2012 Feb 29.*

Purpose: The influence of the modified process in the fiber-reinforced post and resin core foundation treatment on the fracture resistance and failure pattern of premolar was tested in this study. **Methods**: Thirty-six human mandibular premolars were divided into 4 groups (n = 9). In group DCT, the quartz fibre post (D.T. Light-Post) was cemented with resin cement (Duo-Link) and a core foundation was formed with composite resin (Light-Core). In group DMO and DMT, resin cement (Duo-Link) was used for post (D.T. Light-post) cementation and core foundation; in group DMO, these procedures were performed simultaneously in one step, while DMT group was accomplished in separated two steps. In group LCT, the glass fiber post (LuxaPost) cementation and core foundation was accomplished with composite resin (LuxaCore-Dual) in separated procedures. Tooth were prepared with 2 mm ferrule and restored with nickel-chromium crowns. A static loading test was carried out and loads were applied to the buccal surface of the buccal cusp at a 45 degree inclination to the long axis of the tooth until failure occurred. The data were analyzed with MANOVA (α = .05). The failure pattern was observed and classified as either favorable (allowing repair) or unfavorable (not allowing repair). **Results:** The mean fracture strength was highest in group DCT followed in descending order by groups DMO, DMT, and LCT. However, there were no significant differences in fracture strength between the groups. A higher prevalence of favorable fractures was detected in group DMT but there were no significant differences between the groups. **Conclusion:** The change of post or core foundation method does not appear to influence the fracture strength and failure patterns. **PDF**

Keçeci, AD, Heidemann, D, Kurnaz, S. **Fracture resistance and failure mode of endodontically treated teeth restored using ceramic onlays with or without fiber posts-an ex vivo study.** *Dent Traumatol. 2016 Aug;32(4):328-35. doi: 10.1111/edt.12252. Epub 2015 Dec 28*

AIM: This study aimed to compare the fracture resistance and fracture modes of ceramic onlay restorations with or without fiber posts in endodontically treated premolars. **Methods:** Fifty extracted human premolars with similar anatomic features were used in this study. Four groups (n = 10) were treated endodontically. Onlay cavities extended to the buccal and palatal cusps and reached out the endodontic accesses were prepared. Ceramic onlay restorations with or without fiber posts were categorized as Group CO (ceramic onlays without posts), Group COQF (ceramic onlays and **quartz fiber posts),** and Group COGF (ceramic onlays and glass fiber posts). Positive control group was left as non-restored (Group NR). Ten intact teeth were stored as negative control group (Group IT). Fracture resistance was measured using a universal load-testing machine applying compressive load at a cross-head speed of 1 mm min (-1) until fracture. Fracture resistance and modes were evaluated statistically. **Results:** Ceramic onlay restorations (Groups CO, COQF, COGF) increased the fracture resistance significantly, when compared with non-restored teeth ($P < 0.05$). However, no significant differences were found in the groups with fiber posts in terms of fracture resistance ($P > 0.05$). Negative control group (IT) had significantly higher fracture resistance than all others ($P < 0.05$). Fracture types had significant differences among the groups ($P < 0.01$). **Conclusions:** Within the limitations of this ex-vivo study, partial coverage with ceramic onlays resulted in a significant improvement of the fracture resistance of endodontically treated premolars. However, insertion of glass or quartz fibers did not increase the fracture resistance significantly.

Kivanc, B., Gorgul, G. **Fracture resistance of teeth restored with different post systems using new generation adhesives.** *Jnl of Contemporary Dental Practice, Vol. 9, No.7., November 1, 2008.*

Aim: The aim of this study was to investigate the fracture strength of three post systems cemented with a dual cure composite resin luting cement by using different adhesive systems. **Methods:** In this study 63 extracted anterior teeth with single roots were endodontically prepared and filled. Teeth were randomly assigned to one of three post systems placed into the prepared canals: Group I - titanium posts (n=21) (Filpost); Group II - glass fiber posts (n=21) (Mirafit White); and Group III zirconia posts (n=21) (CosmoPost). Each group was again randomly divided into three subgroups according to the bonding materials used [Single Bond (n=7), Clearfil SE Bond (n=7), and Prompt L Pop (n=7)]. A dual cured resin cement (Rely X ARC) was used for bonding the

posts into the root canals. Standard cores were made by a composite resin (Clearfil Photocore) using core build-ups. The samples were tested in the compression test machine for 1 mm/min and fracture resistance of the teeth were recorded. The data was analyzed by using two-way analysis of variance (ANOVA) and Duncan's New Multiple Range Tests. A significance level of $p<.05$ was used for all comparisons. **Results:** There was a significant difference in fracture resistance between the post systems ($p<0.05$) and the interaction of adhesive resins and post systems ($p<0.05$). Mirafit White was more resistant to fracture than other groups; Filpost showed the least resistance to fracture. CosmoPost post system bonded with Single Bond recorded the lowest fracture resistance ($p<0.05$). **Conclusion:** Endodontically treated anterior teeth restored with glass fiber posts exhibited higher failure loads than teeth restored with zirconia and titanium posts. Self-etching adhesives are better alternatives to etch-and-rinse adhesive systems for luting post systems. **Clinical Significance:** Under the condition of this study, glass fiber posts are preferable to restore endodontically treated anterior teeth. **PDF**

Li, Q, Yan, P, Chen, Z. **Fracture resistance and failure patterns of open apex root teeth with different posts after endodontic treatment**. *J Med Sci. 2011 Apr;31(2):271-6. Epub 2011 Apr 20*

The aim of this study is to investigate the influence of different posts on the fracture mechanics of endodontically-treated teeth with open apex. Forty-eight human maxillary anterior teeth were collected, and the root was transversely sectioned 12 mm under the cement-enamel junction (CEJ). These samples were then randomly divided into two groups, i.e., minor diameter open apex root (group A) and major diameter open apex root (group B), with mineral trioxide aggregate (MTA) placed into the apical 4 mm in the root canals. Subsequently, both groups were respectively further divided into three subgroups as follows: fiber-post (subgroup 1), metal post (subgroup 2) and non-post (subgroup 3) group. Teeth were restored with a composite resin crown and tested by using a universal testing machine at the rate of 1 mm/min cross-head. Values of the maximum fracture resistance and failure patterns were recorded and compared among all subgroups. In addition, the changes of MTA properties were carefully examined via X-ray photography. Our results indicate that (1) In group A, the mean value of fracture resistance for teeth restored with fiber posts were statistically higher than that with either metal post or non-post; (2) In group B, there was no statistically significant difference in the mean value of fracture resistance among three subgroups; (3) No statistical significance in the mean value of fracture resistance was found between group A and group B; (4) The failure modes of most samples (58%) were irreparable; (5) MTA in two teeth developed cracks after loading tests. In conclusion, endodontically-treated teeth restored with fiber posts are more resistant to fracture than those restored with either metal posts or non-post, and most of the fracture modes are catastrophic in nature.

*Maccari, PC, Cosme, DC, Oshima, HM, Burnett, LH Jr, Shinkai, RS **Fracture strength of endodontically treated teeth with flared root canals and restored with different post systems.** *J Esthet Restor Dent. 2007;19(1):30-6;*

Background: Many post systems are available to clinicians, yet no consensus exists about which one is better in restoring endodontically treated teeth. **Purpose:** This study evaluated the fracture strength of teeth with flared canals and restored with two fiber-reinforced resin systems (glass fiber: FRC Postec [Ivoclar Vivadent, Schaan, Liechtenstein]; quartz fiber: D.T. Light-Post (RTD, St Egreve, France/ Bisco Dental Products), and one custom cast base metal (Ni-Cr) post and core system. **Methods:** Thirty anterior teeth had their crowns removed below the cemento-enamel junction and were endodontically treated. The canals were prepared for post fixation, and the canal walls were flared using a taper diamond bur. The prepared roots were randomly divided into three groups according to the post system. All posts were cemented with an adhesive resin cement. For the fiber-reinforced resin posts, cores were built up using microhybrid composite. Metallic crowns were luted using zinc phosphate cement. Specimens were loaded at 45 degrees in a universal testing machine at a crosshead speed of 0.5 mm/min until failure. The mode of failure was classified as repairable or nonrepairable. **Results:** Teeth restored with cast posts had fracture strength twice that of teeth restored with resin posts. Fiber-reinforced resin posts failed at a compressive force comparable to clinical conditions, but all failures were repairable. **Conclusions:** Fracture strength and mode of failure in anterior teeth with flared canals varied according to the type of post used to support a crown. **PDF**

Mangold, JT, Kern, M..**Influence of glass-fiber posts on the fracture resistance and failure pattern of endodontically treated premolars with varying substance loss: An in vitro study**. *J Prosthet Dent. 2011 Jun;105(6):387-93*

Statement of problem: It is unclear how the amount of substance loss affects whether the fracture strength of endodontically treated and crowned teeth is increased by post placement. **Purpose**: The purpose of this in vitro study was to evaluate the influence of glass-fiber post placement on the fracture resistance of endodontically treated premolars with varying degrees of substance loss. **Methods:** Sixty-four extracted and endodontically treated mandibular premolars were divided into 4 test groups (n=16) depending on the number of residual coronal dentin walls that ranged from 3 to zero. Teeth in subgroups were either adhesively restored with composite resin (ClearFil Core) without a post (-) or with an adhesively luted glass-fiber post (ER Dentin-Post) (+). After receiving a 0.8-mm shoulder preparation, providing a ferrule of 0.5 mm, teeth were restored with complete metal crowns, which were cemented with glass ionomer cement. All specimens were subjected to dynamic loading in a masticatory simulator for 1.2 million loading cycles with a nominal load of 49 N at 1.2 Hz combined with thermal cycling (between 5 and 55°C, 30-second dwell time). Then specimens were quasi-statically loaded at 30 degrees in a universal testing machine until fracture. Data were analyzed with 2-way ANOVA, followed by multiple comparisons using Tukey HSD test ($\alpha=.05$). **Results:** No specimen failed during masticatory simulation. Mean final fracture resistance ranged from 335.6 ±39.7 N to 1064.9 ±211.8 N. Two-way ANOVA revealed that both the number of residual coronal walls and post placement had a significant influence on the fracture resistance

(P<.001). However, pair-wise comparisons of groups showed that in groups with 2 or 3 cavity walls, the post effect was not statistically significant (P=.378 and P=.175, respectively). **Conclusions:** The fracture resistance of endodontically treated premolars was dependent on the number of residual coronal dentin walls. Placement of a glass-fiber post had a significant influence on the fracture resistance when fewer than 2 cavity walls remained but no significant influence when 2 or 3 walls were present.

Martinez-Insua, A., DaSilva, L., Rilo, B., and Santana, U. **Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core.** *Journal of Prosthetic Dentistry. 80: 527-532, 1998.*

Statement of problem: The survival of pulpless teeth restored with a post and core system is a controversial issue. **Purpose:** This study compared the fracture resistance of 2 types of restorations: teeth restored with prefabricated carbon-fiber (Composipost) posts and composite cores to cast dowel-core restored teeth. **Methods:** A total of 44 recently extracted sound premolars were randomly distributed into 2 equal groups: group I, restored with prefabricated carbon-fiber post and a composite core; and group II, with custom-cast type III gold alloy post and cores. The size and shape of the posts were identical in the 2 groups. All teeth were fully covered with a nonprecious cast crown. Fracture resistance was measured by applying a point force at 45 degrees to the long angle of the tooth. **Results:** Mean fracture threshold was 103.7 $\pm$ 53.1 kg for group I versus 202.7 $\pm$ 125.0 kg for group II (differences significant with $P = .003$). In group II, however, fracture nearly always affected the tooth itself, whereas in group I, the post-core nearly always failed first. **Conclusions:** Significantly higher fracture thresholds were recorded for the cast post and core group. Teeth restored with cast posts typically showed fracture of the tooth, although at loads rarely occurring clinically. **PDF**

*Mekayarajjananonth, T., Chitcharus, N., Winkler, S., Bogert, M.C. **The effect of fiber dowel heights in resin composite cores on restoration failures of endodontically treated teeth**. *J Oral Implantol. 2009;35(2):63-9.*

In vitro and in vivo testing suggest that fiber posts may reduce the incidence of root fractures of endodontically treated teeth. The purpose of this in vitro study was to compare the effect of fiber post height in resin composite cores on the **fracture resistance** of endodontically treated teeth. Forty maxillary central incisors were randomly divided into 2 control groups (Groups 1 and 2) of 5 teeth each, and 3 experimental groups (Groups 3, 4, and 5) of 10 teeth each. The teeth in Group 1 had their opening restored with composite resin, the teeth in Group 2 were restored with quartz fiber posts (D,T. Light-Post, RTD, St Egreve, France) without resin composite cores, and the teeth in Groups 3, 4, and 5 were restored with quartz fiber posts of 2, 4, and 6 mm high, respectively, in 6-mm resin composite cores. Ceramic crowns were fabricated for the specimens. Specimens were positioned in a mounting device and aligned at a 130-degree angle to the long axis of each tooth. A universal testing machine was used to apply constant load at a crosshead speed of 0.5 mm/min until failure occurred. The highest fracture load and mode of failure of each specimen was recorded. The highest fracture resistance force was observed in Group 2 (290.38 +/- 48.45 N) and decreased, respectively, in Group 1 (238.98 +/-26.26 N), Group 5 (228.35 +/-58.79 N), Group 4 (221.43 +/-38.74 N), and Group 3 (199.05 +/-58.00 N). According to one-way analysis of variance (ANOVA) and Duncan's test (P < or = .05), there was no statistically significant increase in the force from Group 3 to Group 5, and the force in Group 2 was significantly higher than that of the experimental groups. There was no statistical significance difference in force among the experimental groups, and the amount of residual tooth structure was found to be the critical factor in fracture resistance. The results suggest that endodontically treated teeth should be restored with the longest possible post height while preserving maximum tooth structure. **PDF**

Meng, QF, Chen, YM, Guang, HB, et al. **Effect of a ferrule and increased clinical crown length on the in vitro fracture resistance of premolars restored using two dowel and core systems**. *Oper Dent, 2007 32-6, 595-601*

Summary: This study investigated the effect of a crown-lengthening ferrule on the fracture resistance of endodontically-treated teeth restored with two dowel-core systems. Thirty-two extracted mandibular first premolars were sectioned perpendicular to the long axis at a point 1.0 mm occlusal to the buccal cementoenamel junction. Following endodontic treatment, the teeth were randomly assigned to four groups: cast Ni-Cr alloy dowel-core with no ferrule (Group A1), cast Ni-Cr alloy dowel-core with 2.0 mm ferrule (Group A2), prefabricated carbon fiber-reinforced dowel-resin core with no ferrule (Group B1) and carbon fiber-reinforced dowel-resin core with 2.0 mm ferrule (Group B2). Each specimen was embedded in a self-cured acrylic resin block from 2.0 mm apical to the margins of a cast Ni-Cr alloy crown, then loaded at 150 degrees from the long axis in a universal testing machine at a crosshead speed of 1.0 mm/minute until fracture. The data were recorded and analyzed using ANOVA and Fisher's exact tests, with alpha = 0.05. Mean failure loads (kN) for the A1, A2, B1 and B2 Groups (ComposiPost-RTD, St Egreve, France / C-POST/ Bisco Dental) were: 1.46 (S.D. 0.45), 1.07 (0.21), 1.13 (0.30) and 1.02 (0.27). The teeth restored with cast Ni-Cr dowel-cores and 2.0 mm ferrules demonstrated significantly lower fracture strengths, $p = 0.04$. There were significant differences in the root fracture patterns between the two dowel systems, with the carbon fiber-reinforced dowel-resin core system, being the less severe $p < 0.05$. Crown lengthening with a 2.0 mm apical extended ferrule resulted in reduced fracture strengths for endodontically-treated teeth restored using two dowel-core systems and cast metal crowns. The carbon fiber-reinforced dowel-resin core system reduced the severity of the root fractures. **PDF**

*Mortazavi, V, Fathi, M, Katiraei, N, Shahnaseri, S, Badria,n H, Khalighinejad, N. **Fracture resistance of structurally compromised and normal endodontically treated teeth restored with different post systems: An in vitro study**. *Dent Res J (Isfahan). 2012 Mar;9(2):185-91.*

Background: With the aim of developing methods that could increase the fracture resistance of structurally compromised endodontically treated teeth, this study was conducted to compare the effect of three esthetic post systems on the fracture resistance and failure modes of structurally compromised and normal roots. **Methods:** Forty five extracted and endodontically treated maxillary central teeth were assigned to 5 experimental groups (n=9). In two groups, the post spaces were prepared with the corresponding drills of the post systems to be restored with double taper light posts (D. T. Light-Post) (group DT.N) and zirconia posts (Cosmopost) (group Zr.N). In other 3 groups thin wall canals were simulated to be restored with Double taper Light posts (DT.W), double taper Light posts and Ribbond fibers (DT+R.W) and Zirconia posts (Zr.W). After access cavity restoration and thermocycling, compressive load was applied and the fracture strength values and failure modes were evaluated. Data were analyzed using two-way ANOVA, Tukey and Fisher exact tests (P<0.05). **Results:** The mean failure loads (N) were 678.56, 638.22, 732.44, 603.44 and 573.67 for groups DT.N, Zr.N, DT.W, DT+R.W and Zr.w respectively. Group DT+R.W exhibited significantly higher resistance to fracture compared to groups Zr.N, DT.W and Zr.w (P<0.05). A significant difference was detected between groups DT.N and Zr.W (P=0.027). Zirconia posts showed significantly higher root fracture compared to fiber posts (P=0.004). **Conclusion:** The structurally compromised teeth restored with double taper light posts and Ribbond fibers showed the most fracture resistance and their strengths were comparable to those of normal roots restored with double taper light posts. More desirable fracture patterns were observed in teeth restored with fiber posts.

Nam, SH, Chang, HS, Min, KS, Lee, Y, Cho, HW, Bae, JM. **Effect of the number of residual walls on fracture resistances, failure patterns, and photoelasticity of simulated premolars restored with or without fiber-reinforced composite posts.** *J Endod. 2010 Feb;36(2):297-301. Epub 2009 Dec 10.*

Introduction: This study compared the fracture resistances and the failure patterns of 100 simulated mandibular premolars of a different number of coronal walls (zero to four walls) with or without fiber-reinforced composite (FRC) posts. In addition, the photo-elastic stress distribution was analyzed. **Methods:** The fracture resistance was measured at a 45 degrees angle with a cross-head speed of 1mm/min, and the failure patterns were observed. The photoelastic stress distribution of specimens with or without FRC posts was also evaluated. The fracture resistance was analyzed by analysis of variance and a Duncan's multiple range test (p<0.05). **Results:** In the no post groups, the fracture resistances decreased significantly in groups with two or fewer walls. The FRC post increased fracture resistances significantly, except for the zero-wall group, and optimized the failure patterns. A high stress concentration was observed along the canal space in the no post groups; stress seemed to be distributed in post groups in photoelasticity. **Conclusion:** Within the limitation of the experimental methods of this study, the FRC post was advantageous in lower premolars, especially with two or more walls in terms of the fracture resistance and stress distribution.

*Nothdurft, FP, et al **The fracture behavior of premolar teeth with class II cavities restored by both direct composite restorations and endodontic post systems**. *Journal of dentistry (2008) doi:10 1016/j.jdent.2008.03.004*

Purpose: The aim of this study was to evaluate the influence of different posts on the fracture load and fracture resistance of endodontically treated premolars with class II cavities and direct composite restorations in an ex vivo setting. **Methods:** Forthy eight single rooted premolars were endodontically treated and prepared with standardized M-O (mesio-occlusal) cavities. Eight teeth each received either no posts or were restored with Titanium Screws (BKS), glass fiber posts (DentinPost), quartz fiber posts (DT Light-Post SL). Sixteen teeth were restored with Zirconium Dioxide posts (CeraPost). BKS screws and eight Zirconium Dioxide posts were cemented conventionally with glass ionomer cement; Panavia F resin cement was used for all others. The specimens were restored with direct composite restorations. Eight sound premolars served as the controls. After thermomechanical fatigue testing, the samples were loaded until fracture occurred at an angle of 45^0. All specimens were evaluated for fracture lines. **Results:** The sound (control group) teeth showed the significan highest fracture load (792.5 +/- 210.1), but the group restored with quartz fiber posts differed not significantly from the control group. In the groups restored with the glass fiber posts and titanium screws significant higher fracture load values occurred as in the group with direct composite restorations without posts. The groups with the fiber posts did not show a more favorable fracture mode than the other groups. **Clinical significance**: The use of an intraradicular post in premolars with class II cavities can significantly increase the resistance towards extra-axial forces. **PDF**

*Nothdurft,, FP , Schmitt, T., Motter, PJ, Pospiech, PR. **Fatigue testing of crowned incisors restored with FRC-posts** *J Dent Res.Vol 87 (Spec Iss A) Abstract #1864, 2008 (www.dentalresearch.org)*

Objectives: The aim of the study was to evaluate the influence of fatigue and cementation mode on the fracture behaviour of endodontically-treated bovine incisors restored with crowns and fiber reincorced composite (FRC) posts. **Methods:** Forty-eight endodontically-treated bovine incisors were restored with FRC-posts (D.T. Light-Post, VDW/RTD, St Egreve, France), composite build-ups, and full-cast crowns. In 16 teeth, each of the posts were cemented conventionally with KetacCem (3M Espe) or adhesively with Panavia F (Kuraray) or RelyXUniCem (3M Espe). One-half of the specimens in each group were subjected to thermocycling (5–55°C, x10,000) and mechanical aging (50 N, x1,200,000). Fracture resistance was determined by loading the specimens until fracture at an angle of 45 ° to the long axis of the teeth. The mean fracture loads were analysed applying the non-para-

"Favorable failures" were defined as repairable failures as fractures of the root on or above the level of bone simulation. The results were reported as descriptive. **Results:** Specimens fractured at failure loads of 371 N (Panavia F, Fatigue Testing) to 494 N (KetacCem, Fatique Testing). Comparing the different modes of cementation similar values for fracture load could be found, before fatigue testing as well as afterwards. The roots restored with conventionally-cemented posts revealed no decrease in fracture resistance after fatigue loading; but the difference between fracture loads before and after artificial aging was not statistically significant for any group. Most specimens fractured in a favorable way; only the groups with KetacCem and RelyX UniCem showed an even distribution of fracture modes after simulated aging. **Conclusions:** The loading test showed that neither cementation mode nor fatigue testing had an influence on the load bearing capability of crowned endodontically-treated incisors with FRC posts.

Osada, T., Warota, S. Hu. K., Kawawa, T. **Determining the effect of the post on corono-radicular reconstruction** *J Dent Res. 80 IADR Abstract # 1432; 2002 (www.dentalresearch.org)*

Adhesion between the resin composite and the radicular dentin structure serves an important role by supporting both the core and the superstructure. The aim of this in-vitro study was to investigate the efficacy of two dentin bonding systems and two resin composites on the fracture resistance of pulpless teeth and to determine the effect of the post. Root canal instrumentation was performed for twenty mandibular first premolars and divided into four groups: 1. experimental dentin bonding system (EXP) self-cured resin composite (Clearfil Fll, Kuraray: Fllk; 2. EXP/dual-cured resin composite (Clearfil DC CORE, Kuraray: DC); 3. commercial dentin bonding system (ED primer and Clearfil Photo Bond, Kuraray: ED)(Fll:4 ED/DC. Slowly increasing forces were applied perpendicular to the longitudinal tooth axis in an Instron testing machine with a crosshead speed of 0.5 mm/min. until the root fractured. Results [mean SD (Kgl)] were compared with those previously obtained for with and without the C-POST) (Osada et al. JDR 79: 628.2000) using two-way ANOVA and Scheffe test.There was no significant difference in the dentin bonding system/resin composite combinations. When the post was present, the fracture resistance was significantly improved ($p<0.01$), probably due to reinforcing and supporting of the resin composite core.

Oskoee, PA, Chaharom, ME, Kimyai, S, Oskoee, JS, Varasteh, S. **Effect of two types of composite fibers on fracture resistance of endodontically treated maxillary premolars: an in vitro study**. *J Contemp Dent Pract. 2011 Jan 1;12(1):30-4*

Objectives: The aim of the present study was to evaluate the effect of the use of composite fibers (glass fiber and polyethylene fiber) at the gingival third of mesio-occlusodistal (MOD) cavities on the fracture resistance of endodontically treated premolars. **Methods:** A total of 45 extracted premolars underwent endodontic treatment. MOD cavities, 2.5 ± 0.2 mm thick at the buccal and lingual heights of contour, were prepared, with the gingival cavosurface margin 1.5 mm coronal to the cementoenamel junction. Then the teeth were randomly divided into three groups. In group 1, the cavities were restored with Z250 composite resin without the use of any fibers. In groups 2 and 3, the teeth were restored in the same manner as that in group 1 after placement of glass fiber and polyethylene fiber at the gingival third of the cavities, respectively. Subsequent to thermocycling, fracture resistance of the specimens was measured in Newton (N). **Statistical analysis:** Data were analyzed with one-way ANOVA and a post hoc Tukey test at a significance level of $p < 0.05$. RESULTS: There were significant differences in the means of fracture resistance values between the three groups ($p = 0.001$). Statistically significant differences were observed in the fracture resistance between group 2 and groups 1 and 3 ($p < 0.05$). However, the differences between groups 1 and 3 were not significant ($p = 0.25$). **Conclusion:** The type of fiber influenced the fracture resistance of endodontically treated human premolars. Using glass and/or polyethylene fibers in the gingival third of composite restorations leads to different results in fracture resistance of endodontically treated maxillary premolars.

Padmanabhan. P. A., **Comparative evaluation of the fracture resistance of three different pre-fabricated posts in endodontically treated teeth: An in vitro study.** *J Conserv Dent. 2010 Jul;13(3):124-8.*

Aims: To compare the fracture resistance and primary mode of failure of three different pre- fabricated posts like stainless steel, carbon fiber and ceramic posts in endodontically treated crowned permanent maxillary central incisors. **Methods:** Root canal treatment was performed on all 30 maxillary central incisors. Post space was prepared and samples were divided into three groups of 10 each. The teeth were inserted with pre-fabricated stainless steel, carbon fiber and ceramic post and cemented using adhesive resins, core fabricated and crowns placed. Mode of failure was carried out by immersing the teeth in black ink for 12 h and then sectioning them mesio-distally. Fracture above the embedded resin was considered favorable and fracture below the resin level was considered unfavorable. **Statistical analysis:** Fracture strength was measured using a universal testing machine. Data were evaluated statistically using the Kruskal Wallis test and the Mann Whitney "U"-test. Mode of failure was evaluated statistically using the chi-square test. **Results:** There was a statistically significant difference showing that the stainless steel post had a better fracture resistance when compared with the other two posts and the carbon fiber showed a statistically more favorable fracture when compared with the other two posts. **Conclusions:** Within the limitations of this study, it can be concluded that the pre-fabricated stainless steel post exhibited a significantly higher fracture resistance at failure when compared with the carbon fiber post and the ceramic post. The mode of failure of the carbon fiber post was more favorable to the remaining tooth structure when compared with the pre-fabricated stainless steel post and the ceramic post.

*Pongpatarin, A., Salimee, P. **Effect of furrule and FRC-post diameter in restoring endodontically-treated teeth.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2190, 2010 (www.dentalresearch.org)*

Objectives: To evaluate the effect of furrule and FRC post diameter in restoring endodontically-treated teeth using fracture resistance test. **Methods:** Thirty two extracted human maxillary central incisors were randomly divided for 4 groups (n=8); group 1: ferrule+post fit, group 2: ferrule+smaller post, group 3: no ferrule+post fit and group 4: no ferrule+smaller post. Teeth were cut horizontally for root length 15 mm. Root canal treatment were performed and post space were prepared using DT Light-Post drill no.2. In group 1 and 3, teeth were restored with DT Light-Post no.2, while in group 2 and 4 using DT Light-Post no.1. posts (RTD, St Egreve France) were cemented with resin cement (Panavia F 2.0), core built-up were made with resin composite (Tetric N ceram). Chamfer preparation were performed around the teeth with furrule of 2 mm. in group 1 and 2, but not in group 3 and 4. Ni-Cr crowns were made to fit and cemented with resin cement. Restored teeth were embedded in resin blocks with stimulated PDL. Specimens were loaded on a universal testing machine with crosshead speed 1 mm/min on palatal surfaces, 135 degree to long axis of the tooth until failure occurred. **Results:** The fracture resistance of group 1, 2, 3 and 4 were 1474.7±285.5 N, 1339.4±120.6 N, 811.7±155.7 N and 668.5±170.2 N, respectively. Two-way ANOVA and Tukey HSD post-hoc analysis revealed that fracture resistance of group 1 and 2 were significantly higher than group 3 and 4 ($p<0.05$). Significant difference was not found between group 1 and 2 or between group 3 and 4 ($p>0.05$). **Conclusions:** Present of ferrule significantly affect the fracture resistance of endodontically-treated teeth restored with FRC post. While using post with smaller diameter did not significantly affect the fracture resistance compared with using post that properly fit to the canal.

Rodriguez-Cervantes, F., Sancho-bru, J., Barjau-Escribano, A., Forner-Navarro, L., et al. **Influence of prefabricated post dimensions on restored maxillary incisors.** *Journal of Oral Rehabilitation 2007, 34; 141-152.*

Summary: The aim of this study was to test the following hypothesis: biomechanical performance (fracture strength and stress distribution) of restored teeth is less sensitive to post diameter and post length when using fibre posts than when using stainless steel posts. First, an experimental fracture strength test was performed on 80 extracted human maxillary central incisors. Teeth were decoronated, treated endodontically and restored (40 with glass fiber posts and 40 with stainless steel posts), and the length and diameter of the posts varied uniformly. Failure loads were recorded and results were compared using an ANOVA analysis. Secondly, the finite element technique was used to develop a model of the restored tooth. The post diameter had a significant effect on the biomechanical performance of teeth restored with stainless steel posts; LOWER failure loads were found as post diameter increased. However, the post diameter in those teeth restored with fibre posts, and the post length for both systems under consideration did not affect the biomechanical performance of restored teeth to a significant degree. The stress distributions predicted by the developed model confirmed these findings, confirmed the assumed hypothesis, and permitted the the proposal of the use of fiber posts to achieve a restorative technique that is less sensitive to post dimensions, and thus more robust. **PDF**

Rosentritt, M., Sikora, M., Behr, M., Handel, G**. In vitro fracture resistance and marginal adaptation of metallic and tooth-colored post systems.** *J Oral Rehabil, 2004 Jul;31(7):675-81.*

Summary: The aim of this *in vitro* study was to compare the fracture resistance and marginal adaptation of all-ceramic incisor crowns with all-ceramic posts, glass–fibre-reinforced posts and titanium posts as well as a control without any post. Three groups of eight maxillary incisors were restored with an all-ceramic post, a fibre-reinforced composite (FRC) post, a titanium post and a further group was restored without posts. Composite cores were provided and all-ceramic crowns were adhesively luted. After artificial ageing, the fracture resistance of the restored teeth was determined. The marginal adaptation of the restorations at the interfaces between cement-tooth and cement-crown was evaluated with scanning electron microscopy using replica specimen before and after ageing. The restored teeth without posts [270N (235/335)] showed no significantly different fracture strength compared with teeth with the titanium system [340N (310/445)]. The all-ceramic posts [580N (425/820)] and the FRC posts [505N (500/610)] both provided a significant higher fracture resistance than the teeth without posts. Prior to ageing, all materials showed <5% separation at the margins cement-tooth or cement-crown ('marginal gap'). After ageing, the interfaces of all systems deteriorated to values between 6 and 14% marginal gap. The greatest marginal gap was found with the titanium system (14%) at the interface cement-crown and with the all-ceramic posts (12%) at the transition between cement-tooth. Regarding fracture resistance and the marginal adaptation, the all-ceramic and FRC posts may be considered as an alternative to the commonly used titanium post restorations. **PDF**

Salameh, Z, Sorrentino, R, Papacchini, F., Ounsi, HF, Tashkandi, E, Goracci, C, Ferrari, M**. Fracture resistance and failure patterns of endodontically treated mandibular molars restored using resin composite with or without translucent glass fiber posts.** *J Endod. 2006 Aug;32(8):752-5.*

The elastic modulus of the restorative material is important in restoring endodontically treated teeth. This study aimed to compare the fracture resistance and failure patterns of 90 mandibular molars restored using resin composites with or without fiber posts, with respect to the number of residual cavity walls. Five restoration types were performed corresponding to different wall defects (groups 1-5). Groups were divided in two subgroups corresponding to the use or absence of fiber posts. Teeth were loaded and resistance of specimens was measured as the axial compressive load to cause fracture and macroscopic fracture patterns were observed. One way ANOVA revealed a significant difference in fracture resistance ($p < 0.001$). Tukey post hoc test also revealed

that the resistance of endodontically treated mandibular molars restored with composite resins is mainly affected by the number of residual walls. Using fiber-reinforced posts optimized fracture patterns. **PDF**

Salameh, Z, Sorrentino, R,. Ounsi, H, Goracci, C., Tashkandi, E, Tay, F, Ferrari, M. **Effect of different all-ceramic crown system on fracture resistance and failure pattern of endodontically treated maxillary premolars restored with and without glass fiber posts**. *J Endod 2007 July Volume 33, Issue 7, 848-851*

Abstract: Endodontically treated teeth are traditionally restored with a crown to prevent fracture. The aim of this study was to compare the fracture resistance and failure modes of endodontically treated maxillary premolars treated with or without a fiber post and restored with different types of crowns. Eighty human maxillary premolars were selected. After root canal treatment, the teeth were embedded in resin blocks and divided into four groups. Samples received MOD cavity preparations and were divided into two subgroups: with and without fiber posts and restored using porcelain fused to metal, lithium disilicate, fiber-reinforced composite, or zirconia crowns. The specimens were vertically loaded in the central fossa using a universal loading machine until failure, and the maximum breaking loads were recorded. Samples were perfused with Indian ink to highlight the fracture lines and the mode of failure that was classified as restorable or non-restorable. Even without post, all crown designs resisted vertically applied forces beyond those that may be encountered in the mouth. Two-way analysis of variance revealed the use of a fiber post ($p = 0.007$) and the type of crown ($p < 0.001$) significantly affected the restorability of fractured teeth. The relationship between placing or not placing the post and the type of failure (restorable/non-restorable) was found to be significant ($\chi 2$ test, $p = 0.002$). Although post placement resulted in higher fracture resistance values, these were significant for Empress II crowns only. The results suggest that the posts could contribute to the reinforcement and strengthening of pulpless maxillary premolars. With respect to failure modes, placement of fiber posts improved the fracture from non-restorable to restorable patterns. This study suggests that the placement of fiber posts is necessary to improve fracture resistance even under full-coverage crowns. **PDF**

Salameh, Z, Ounsi, HF, Aboushelib, MN, Sadig, W, Ferrari, M. **Fracture resistance and failure patterns of endodontically treated mandibular molars with and without glass fiber post in combination with a zirconia-ceramic crown.** *J Dent. 2008 Jul;36(7):513-9. Epub 2008 May 13*

Objective: The aim of this study was to investigate the influence of a fiber post on the fracture mechanics of zirconia crowns inserted over endodontically treated teeth with different extent of coronal damage. **Methods:** Endodontically treated human molars with three types of coronal damage received fiber posts before cementation of zirconia-veneered crowns. Controls received composite resin cores without fiber posts. The specimens were loaded to failure and fractographically examined using a scanning electron microscope (SEM). **Results:** Statistical analysis revealed that specimens with fiber posts demonstrated significantly higher failure loads and favorable fracture pattern compared to the controls. At fractographic analysis, specimens with fiber posts demonstrated delamination of the veneer ceramic from intact zirconia under structure. Meanwhile, the specimens that were restored without a fiber post demonstrated micro-cracking of the composite core build-up resulting in loss of the support under the zirconia crowns which was responsible for the initiation of radial crack and catastrophic damage. **Conclusions:** Within the limitation of this study, the insertion of fiber post improved the support under zirconia crowns which resulted in higher fracture loads and favorable failure type compared to composite core build-up.

Salameh, Z., Sorrentino, R., Ounsi, H. et, al The **Effect of different full coverage crown systems on fracture resistance and failure pattern of endodontically treated maxillary incisors restored with and without glass fiber posts**. *J Endod 2008; 34:842-846.*35

Abstract: The aim of this study was to compare the fracture resistance and failure pattern of endodontically treated maxillary incisors restored using composite resin with or without fiber-reinforced composite (FRC) posts under different types of full coverage crowns. The null hypothesis tested was that fracture resistance and the failure pattern were not affected by the use of FRC posts or by the type of full coverage crown. One hundred twenty maxillary incisors were endodontically treated and divided into 4 groups of 30 each. Each group was divided into 2 sub-groups; restoration with or without fiber post. PFM crowns were placed in Group 1, Empress II crowns in Group 2, SR Adoro crowns in Group 3 and Cercon crowns in group 4. Fracture tests were performed by loading specimens to fracture. Data were analyzed with two-way analysis of variance ($\alpha = 0.05$). The type of crown was not a significant factor affecting fracture resistance ($\alpha = 0.04$). Both the presence of a post and the type of crown had a significant influence on the proportion of restorable versus UNrestorable fractures. Although prosthodontic textbooks do not generally advocate the placement of fiber posts in endodontically treated incisors, the results of this study indicate that the use of fiber posts in such teeth increases their resistance to fracture and improves the prognosis in the case of fracture. **PDF**

Santos Filho, PCF, Soares, PV., Martins, LRM., Silva, GR, Soares CJ **Biomechanical analysis of the restorative procedure of endodontically treated anterior-teeth** *Dent Res.Vol 87 (Spec Iss A) Abstract #1858, 2008 (www.dentalresearch.org)*

Objectives: To investigate in vitro the effects of different post systems and lengths on stress distribution, strain and fracture resistance of endodontically treated teeth. **Methods:** 135 bovine incisors were sectioned 15mm from apex and have root filled, embedded in polystyrene resin simulating periodontal ligament. Roots were divided into 3 groups (n=45): fiber-glass-post (Fgp); prefabricated-steel-post (Psp); cast-post and core (Cpc). Each group was divided into 3 subgroups (n=15) according to post length: L5- 5.0 mm; L7.5- 7.5 mm; L10- 10.0 mm. All teeth were restored with metal crowns. For strain-gauge test, 2 strain-gauges per

sample were used. The fracture resistance was assessed by compressive loading in universal test machine. Data were analyzed with 2-way ANOVA and Tukey HSD test ($p<0.05$). Finite element analysis was realized by 2D-models and the stress distribution was analyzed by von Mises criterious. **Results:** Fracture resistance values (N) were: Fgp- L10:618.5±177.5^{Aa}, L7.5:615.5±127.7^{Aa}, L5:607.2±139.7^{Aa}; Cpc- L10:769.9±68.5^{Aa}, L7.5:540.0±86.2^{Bab}, L5:399.2±90.0^{Cb}; Psp- L10:698.8±96.8^{Aab}, L7.5:502.8±134.7^{Bb}, Pl5:390.2±94.6^{Cb}. Strain values (μS) were: Fgp- L10: 78±22^{Aa}, L7.5:80±15^{Aa}, L5: 80±15^{Aa}; Cpc- L10: 90±25^{Aab}, L7.5: 130±44^{Bb}, L5: 200±93^{Cb}, Psp- L10:106±44^{Ab}, L7.5:138±44^{Bb}, L5: 216±57^{Cb} (Capital letters represent analysis among length post for each post system and lower case letter represent analysis among post systems for each length). Strain values were lowers in Fgp groups than Cpc and Psp groups. Fracture modes of Cpc and Psp groups were no reparable and all fracture modes of Fgp were reparable. Stress distribution of Cpc and Psp concentrated into root dentin- post interface. Fgp showed homogeneous stress distribution. **Conclusions:** The cast post and core with 10.0 mm showed the highest fracture resistance; however the fiber-glass-post was effective with the three post lengths, showing higher fracture resistance than metal posts when the length was 5.0 mm with lower strain levels and the best stress distribution.

Santos, AF, Meira, JB, Tanak,a CB, Xavier, TA, Ballester, RY, Lima RG, Pfeifer CS, Versluis A. **Can fiber posts increase root stresses and reduce fracture?** *J Dent Res. 2010 Mar 26.*

The clinical success of fiber posts has been attributed to their lower elastic modulus. The tested hypothesis was that fiber posts could lead to lower risk of post debonding and lower risk of root fracture, despite an increase in root stresses. Stress analyses were carried out with a 3D finite element model of a premolar restored with a metallic or a fiber post. Bonded and non-bonded post/cement interface conditions were simulated. We calculated risk-of-fracture indices by determining the highest principal stress values divided by the tensile strength. Shear stresses along the post/cement interface were analyzed for the bonded models. Compared with the premolar restored with a metallic post, the fiber post generated lower stresses along the interface and higher stresses in the root. However, with the fiber post, fracture was less likely to occur in the root, since its core and post fracture indices were higher.

Santini, MF, Wandscher, V, Amaral, M, Baldissara,. P, Valandro, LF. **Mechanical fatigue cycling on teeth restored with fiber posts: impact of coronal grooves and diameter of glass fiber post on fracture resistance.** *Minerva Stomatol. 2011 Oct;60(10):485-93.*

Objectives: The aim of this paper was to evaluate the effect of different diameters and surface characteristics of a glass fiber post on the fracture resistance of teeth restored with fiber posts. **Methods:** Eighty single-rooted bovine teeth were prepared, embedded in a PVC cylinder using acrylic resin, and allocated into 8 groups (N.=10) according to post diameter and shape: (smooth double-tapered fiber post) G1, G2, G3, and G4 with cervical diameters of 1.4 mm, 1.6 mm, 1.8 mm, and 2 mm, respectively; (double-tapered fiber posts with coronal grooves) G5, G6, G7, and G8 with cervical diameters of 1.4 mm, 1.6 mm, 1.8 mm, and 2 mm, respectively. A self-adhesive cement was used for post cementation, and the core build-up was standardized and made with composite resin. Specimens were stored for 7 days and then submitted to the mechanical fatigue testing (load=50 N., angle= 45°, frequency=1 Hz, temperature=37 ± 1 °C, number of cycles=1000000); the specimens that survived were submitted to static resistance testing (1 mm/min, 45°). The fracture loads and fracture modes was recorded. Data were submitted to 2-way ANOVA, post-hoc Tukey test and Pearson Correlation analysis. **Results:** The cervical diameter of the post ($P<0.0001$) and surface characteristics ($P=0.01013$) significantly affected the fracture resistance (2-way ANOVA). Grooves reduced the fracture resistance when post diameter was 1.4 mm (G1 and G5). A moderate positive correlation was found between the fracture resistance and the fiber post diameter ($r2=0.4445$; $P<0.0001$) (Pearson correlation test). **Conclusions:** It appears that there is a direct relation between the diameter of the fiber post and the fracture strength of roots restored with fiber posts. But other factors may have influenced the fracture strength such as the reduction of intracanal dentin by the preparation for placement of wider fiber posts, since no difference was found for smooth fiber posts with different diameter. Otherwise, grooves at coronal part of the fiber post can damage the fracture resistance.

Schiavetti, R. , Sannino, G. **In vitro evaluation of ferrule effect and depth of post insertion on fracture resistance of fiber posts.** *Computational and Mathematical Methods in Medicine Volume 2012, Article ID 816481, 6 pages doi:10.1155/2012/816481*

Purpose: The analysis of the complex model of fiber post and ferrule is given and studied in this paper. A novel approach and a solution to the evaluation of stress of post and core system within the ferrule effect are proposed. **Methods:** Sixty freshly extracted premolars were selected for the study. The following experimental groups were therefore defined (n = 10): (1) 5 mm, (2) 7 mm, (3) 9 mm, (4) ferrule-5 mm, (5) ferrule-7 mm, and (6) ferrule-9 mm. Pre-shaping drills (C) were used to prepare the root canals at 5, 7, and 9 mm in depth. In specimens of groups 3–6 a circumferential collar of tooth structure of 2 mm in height. Fluorocore 2 core build-up material (I) was used for fiber post luting. With the same material, a buildup of 2 mm in height was created. A controlled compressive load (crosshead speed: 0.75 mm/min) was applied by means of a stainless steel stylus (Ø 1 mm) at the coronal end of the post extruding out of the root. **Results:** In all the tests the level of significance was set at $P < 0.05$. Significantly higher fracture strengths were measured in the presence of a ferrule effect. In groups 1, 2, and 3 (ferrule group), the mean fracture values were, respectively, 163,8 N, 270,9 N, and 254,7 N. These data are higher and statistically significantly different when compared with the three groups 4, 5, and 6 (no-ferrule group), in which the values obtained were, respectively, 40,5 N, 41,7

N, and 44,9 N. **Conclusion:** The ferrule effect in the endodontically treated teeth positively affects the fracture strength of the fiber post. Conversely, post depth insertion did not affect the resistance to fracture.

Scotti, N, Rota, R, Scansetti, M, Paolino, DS, Chiandussi, G, Pasqualini, D, Berutti, E. **Influence of adhesive techniques on fracture resistance of endodontically treated premolars with various residual wall thicknesses.** *J Prosthet Dent. 2013 Nov;110(5):376-82. doi: 10.1016/j.prosdent.2013.08.001. Epub 2013 Oct 3.*

Statement of problem: The choice of restorative method is commonly based on the cavity configuration and the residual number of cavity walls. However, the residual wall thickness could be a valuable clinical parameter in the choice of restoration for endodontically treated teeth. **Purpose**: The fracture resistance of endodontically treated premolars was compared with different wall thicknesses restored with direct composite resin with and without cuspal coverage and with and without fiber post insertion. **Methods:** This study included 104 intact human maxillary premolars extracted for periodontal or orthodontic reasons. Standardized mesio-occluso-distal cavities were prepared with different palatal wall thicknesses (1.5, 2, and 2.5 mm) and a buccal wall thickness of 2 mm. Teeth were restored with or without a fiber post and with or without cuspal coverage. Specimens were subjected to thermocycling (3000 cycles, 5 to 55°C) and embedded in polymerized acrylic resin. Teeth were submitted to cyclic fatigue followed by a static fatigue test with a universal testing machine; a compressive force was applied 30 degrees to the long axis of the teeth until fracture. The results were statistically analyzed by 3-way ANOVA (α=.05). **Results:** Residual wall thickness (P=.004), the type of adhesive restoration (P<.001), and fiber post insertion (P<.001) significantly influenced the fracture resistance of endodontically treated premolars. **Conclusions:** In specimens with a cavity wall thickness >2 mm, direct intracuspal composite resin restorations supported by a fiber post achieved comparable fracture resistance. With a residual wall thickness <2 mm, only cuspal coverage with or without a fiber post provided satisfactory fracture resistance.

*Seraj, B, Ghadimi, S, Estaki, Z, Fatemi, M. **Fracture resistance of three different posts in restoration of severely damaged primary anterior teeth: An in vitro study.** *Dent Res J (Isfahan). 2015 Jul-Aug;12(4):372-8. doi: 10.4103/1735-3327.161461*

Background: Restoration of anterior primary teeth with severe caries lesion is a big challenge. The aim of this study was to compare the fracture resistance of three types of post, including composite resin, customized quartz fiber and prefabricated glass fiber in restoration of severely damaged primary anterior teeth. **Methods:** Sixty extracted human primary maxillary incisors were randomly divided into three groups: Group 1: Customized quartz fiber post, Group 2: Composite post and Group 3: Prefabricated glass fiber post. Due to the effect of bonded area on the fracture resistance, the bonded surface of each sample was measured 1 mm above cemento-enamel junction. An increasing force was subjected with a crosshead speed of 0.5 mm/min by a universal testing machine until fracture occurred, and the failure mode was assessed afterwards. Data were analyzed using One-way analysis of variance and Kruskal-Wallis tests. The level of significance was considered at P < 0.05. **Results:** The mean fracture resistance values of three groups were 343.28 N, 278.70 N and 284.76 N, respectively. Although customized quartz fiber post showed the greatest fracture resistance, statistical analysis revealed no significant difference between groups (P = 0.21). The mean fracture strength values of three groups were 12.82 N/mm(-2), 11.93 N/mm(-2) and 11.31 N/mm(-2), respectively; however, the differences were not statistically significant (P = 0.72). Favorable failure mode was more frequent in all groups (P = 0.12). **Conclusion:** Within the limitations of this study, it can be concluded that all three types of studied posts can be successfully used to restore badly destructed primary anterior teeth. **PDF**

*Seto, B., Chung, KH, Johnson, J., Paranjpe, A**. Fracture resistance of simulated immature maxillary anterior teeth restored with fiber posts and composite to varying depth.** *Dental Traumatology 2012; doi: 10.1111/edt.12020*

Background: Traumatized immature teeth present a unique challenge during treatment, both endodontically as well as restoratively. Hence, the purpose of this study is to evaluate the type and depth of restoration that would be effective in simulated immature maxillary anterior teeth in terms of fracture resistance and mode of failure. **Methods:** Seventy-five extracted human maxillary anterior teeth were used in this study that was standardized to a length of 13 mm. Instrumentation of the canals was performed after which a Peezo no. 6 was taken 1 mm past the apex to simulate an incompletely formed root. MTA apexification was simulated after which all the teeth were mounted and a 3-mm-diameter engineering twist drill extended the preparation 3 and 7 mm below the facial cemento–enamel junction (CEJ) to simulate Cvek's stage 3. These teeth were divided into seven different groups: Group 1: Negative control: intact teeth; Group 2: Positive control: 3 mm, no restoration; Group 3: Positive control: 7 mm, no restoration; Group 4: 3-mm composite; Group 5: 3-mm quartz fiber post; Group 6: 7-mm composite; Group 7: 7-mm quartz fiber post. Fracture resistance was performed at 130° to the long axis of the tooth with a chisel-shaped tip at the cingulum with a crosshead speed of 5 mm min, and the maximum load at which the fracture occurred was recorded. **Results:** Group 1 that was the negative control showed the highest fracture resistance. Among the experimental groups, 4 and 5 showed the highest fracture resistance, which were significantly different from groups 6 and 7, respectively. **Conclusions:** Within the limitations of this in vitro study, it can be concluded that using either dual-cure composite or a quartz fiber post with composite resin to a depth of 3 mm would significantly strengthen the roots in immature teeth.

*Shirani, F., Malekipour, M.**, Effects of non-metallic posts on fracture resistance of weakened teeth.** *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #1619, 2007 (www.dentalresearch.org)*

Objectives: The restoration of severely damaged teeth that have lost support at the coronal portion of the root canal is very difficult. The aim of this study was the evaluation of different methods of root reinforcement by dual-cure composite and various types of non-metallic posts. **Methods:** We performed root canal therapy on 60 maxillary central incisors. The teeth were divided into five groups, and specimens from three groups were prepared to simulate the teeth with flared canals. In the 1st group, no weakening was done. In the 2nd group, the compromised area of the root canal was obturated with gutta percha. In the 3rd group, universal D.T. Light-Posts (RTD, St Egreve, France) were used in the root canal to 8 mm below the margin of the palatal wall, after which the height of the DT post was regulated in the canal pulp chamber space so that it would not be under direct load. The post was then cemented with dual-cure composite. In the 4th and 5th groups, the same procedures were done; however, clear and opaque posts, with shapes and dimensions similar to those of D.T. Light-Posts, were used. In all groups, the access cavity was restored with light-curing composite resin to 0.5 mm under the margins. After being mounted, all specimens were pressed in an Instron machine. At fracture, the amount of force was recorded. **Results:** The highest resistance to fracture belonged to group 1 and the lowest to group 2. The results showed that there was a significant statistical difference, and a Duncan analysis showed that the differences of resistance to fracture were significant in all groups except among groups 3, 4, and 5. **Conclusion:** The use of dual-cure composite resin and non-metallic D.T. Light-Posts can significantly increase the resistance-to-fracture of root-treated maxillary central incisors with thin root walls.

*Shirani, F., Malekipour, M**. In-vitro study of different reinforcement methods of anterior weakened teeth.** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #1732 2005 (www.dentalresearch.org)*

Objectives: The purpose of study was to evaluate the potential of intraradicular reinforcement of layered adhesion technique and two different types of post in structurally compromised roots. **Methods:** Root canal therapies were done on 48 extracted similar maxillary incisors. The samples were divided to 4 groups. In three groups for simulation of specimens to weakened teeth, instrumentation was done 5mm apical to CEJ from access cavity. In positive control group that weakening was not done, restoration of access cavity was done with composite resin (Z100, 3M dental product, USA) and dentin bonding agent (Single bond, 3M dental product, USA). In second group access cavity of the weakened teeth was restored only with composite resin and dentin bonding agent to the level of CEJ. In third group weakened cervical area were reinforced with a dual cure composite (Bis-Core, Bisco, Inc, USA) and translucent quartz fiber post (Light-Post, RTD, St Egreve, France) In the fourth group, the weakened cervical area was reinforced with dual cure composite and cast post with similar morphologic properties. Access cavity in the last two groups were restored with composite resin, then all specimens were tested in an instron machine. **Results:** The mean fracture load for the 4 groups were 170.12, 71.40, 129.36, and 116.6 kgf respectively. The differences between first group and others (P value=0), second group and others (P value=0) were significant. There was no significant differences between third and forth group (P value =0.103), but the rate of restorable fractures (pattern of fracture) was significantly different between these two groups. **Conclusions:** It is concluded that the use of post, dentin bonding agent and a composite resin in a root with thin walls will reinforce the weakened tooth but the type of the post will influence on the final result.

Sorrentino, B., Zarone, F. Ferrari, M. **Effect of the link of glass fiber posts on the fracture resistance of restored maxillary central incisors.** *Am J Dent 2012;25:79-83.*

Purpose: to evaluate the influence of post link insertion on the fracture resistance of directly restored endodontically treated teeth. **Methods:** 30 maxillary central incisors were restored with glass fiber posts (Rely-X Fiber Posts 3M) and composite cores to produce groups with post links of (1) 5mm, (2) 7mm and (3) 9mm. specimens were loaded at 130° (Instron). Fracture strengths were analyzed with the Kolmogorov-Smirnov Test to verify the normality of the data distribution and with ANOVA and Tukey's post hoc test at $P<0.05$. Fracture patterns (restorable or unrestorable) were analyzed (Pearson's Chi square test). **Results**: the average fracture resistance was: group 1= 366.4N, group 2= 507.4N, group 3=509.9N. No significant difference was found among the 3 groups for fracture resistance or for failure mode. The insertion length did not influence the fracture pattern; more restorable fractures were detected. **PDF**

Torabi, K, Fattahi, F. **Fracture resistance of endodontically treated teeth restored by different FRC posts: an in vitro study.** *Indian J Dent Res. 2009 Jul-Sep;20(3):282-7.*

Background: Posts and cores are often required for restoration of pulpless teeth and to provide retention and resistance for a complete crown, but conventional posts may increase the root fracture. **Objective:** This study was performed to compare the root fracture resistance of extracted teeth treated with different fibers reinforced with composite posts and treated teeth with conventional post and core systems. **Methods:** Root canal therapy was performed for 50 mandibular first premolars. The coronal portion of each tooth was amputated, and five post and core systems (cast, polyethylene woven, glass, carbon, and quartz fiber posts) were compared. Acrylic resin blocks were used for mounting, using a layer of elastomeric impression material covering the roots. The load was applied axially and measured with a universal testing machine. **Conclusions**: Significantly, cast posts and cores had a higher failure threshold including teeth fracture; whereas, fiber posts failure was due to core fracture, with or without fractures in coronal portion of posts. Difference in FRC posts did not provide any significant difference in the load failure and the mode of fracture. **PDF**

Vadini, M, Deangelis, F, D'Amario, M, Marzo, G, Baldi, M, D'Arcangelo, C. **Conservative restorations of endodontically compromised anterior teeth in pediatric patients: physical and mechanical considerations**. *Eur J Paediatr Dent. 2012 Oct;13(3 Suppl):263-7.*

Aim: Objective of this in vitro study was to evaluate the influence of fiber post placement on fracture resistance of pulpless anterior teeth restored with standardized Class III and Class IV resin composite fillings. **Methods**: One hundred and five human maxillary central incisors were selected and randomly divided into 7 (n=15) experimental groups (endodontic therapy/ endodontic therapy and one Class III resin composite filling/ endodontic therapy and one Class IV resin composite filling/ endodontic therapy and two Class III resin composite fillings/ endodontic therapy, fiber post and one Class III resin composite filling/ endodontic therapy, fiber post and one Class IV resin composite filling/ endodontic therapy, fiber post and two Class III resin composite fillings). Specimens underwent fracture strength test. Means (N) were calculated and data were analysed using 1-way ANOVA and Tukey multiple comparisons tests (p=0.05). **Results:** Concerning teeth with two Class III, fiber post placement significantly increased fracture strength values from 603.59 to 864.24 N. Specimens restored with one Class III (795.21 N without post, 936.68 N with post) showed higher fracture strength values if compared with specimens with two Class III, with significant differences just concerning specimens without a fiber post. Fracture strength was not significantly influenced by fiber post placement in Class IV groups (720.71 N without post, 799.69 N with post). **Conclusion**: Data suggest that fiber post placement may significantly improve anterior teeth fracture strength when at least two Class III composite fillings are associated to the endodontic treatment. No significant effect of fiber post placement could be recorded when just one Class III or one Class IV composite filling were present.

Zicari F, Coutinho E, Scotti R, Van Meerbeek B, Naert I. **Mechanical properties and micro-morphology of fiber posts**. *Dent Mater. 2013 Apr;29(4):e45-52. doi: 10.1016/j.dental.2012.11.001. Epub 2013 Feb 5.*

Objectives: To evaluate flexural properties of different fiber posts systems and to morphologically characterize their micro-structure. **Methods**: Six types of translucent fiber posts were selected: RelyX Post (3M ESPE), ParaPost Taper Lux (Colthéne-Whaledent), GC Fiber Post (GC), LuxaPost (DMG), FRC Postec Plus (Ivoclar-Vivadent), D.T. Light-Post (RTD). For each post system and size, ten specimens were subjected to a three-points bending test. Maximum fracture load, flexural strength and flexural modulus were determined using a universal loading device (5848 Micro-Tester(®), Instron). Besides, for each system, three intact posts of similar dimensions were processed for scanning electron microscopy to morphologically characterize the micro-structure. The following structural characteristics were analyzed: fibers/matrix ratio, density of fibers, diameter of fibers and distribution of fibers. Data were statistically analyzed with ANOVA. **Results**: Type and diameter of posts were found to significantly affect the fracture load, flexural strength and flexural modulus ($p<0.05$). Regarding maximum fracture load, it was found to increase with post diameter, in each post system ($p<0.001$). Regarding flexural strength and flexural modulus, the highest values were recorded for posts with the smallest diameter ($p<0.001$). Finally, structural characteristics significantly varied among the post systems tested. However, any correlation has been found between flexural strength and structural characteristics. **Signifigance:** Flexural strength appeared not to be correlated to structural characteristics of fiber posts, but it may rather be affected by mechanical properties of the resin matrix and the interfacial adhesion between fibers and resin matrix.

Zogheib, LV, Vasconcellos, LG, Salvia, AC, Balducc,i I, Pagani, C, Bottino, MA, Valandro, LF. **Fracture resistance of bovine incisors restored with different glass fiber posts: Effect of the diameter of fiber post.** *Indian J Dent Res. 2012 Sep;23(5):623-7. doi: 10.4103/0970-9290.107379.*

Aim: Compare the effect of three post designs on the fracture resistance and failure modes of composite core - fiber post - crownless tooth sets. **Methods:** Ninety bovine incisors were selected and divided into nine groups of 10 specimens. The teeth were assigned to three groups based on the post design: Cylindrical, tapered, and double-tapered. Each group was subdivided into three subgroups in accordance with the diameter of the post: Small (No.1), medium (No.2), and large (No.3). The Panavia F system was used for post cementation. The specimens were mounted in acrylic resin blocks with a layer of silicone rubber covering the roots. A universal testing machine compressively loaded the specimens from the palatal side at a crosshead speed of 1 mm/min and at an angle of 135I to the long axis of the teeth, until failure occurred. The failure mode was determined by a stereomicroscope inspection of all the specimens. Data were analyzed by one-way ANOVA and the Tukey test ($P < 0.05$). **Results:** The fracture resistance was affected by the type of post ($P < 0.0001$). A narrower diameter for all of the post systems allowed for higher resistance. The main failure mode in the large cylindrical group was catastrophic fractures, while the main failures in the other eight groups were favorable. **Conclusion:** Narrower diameter posts showed higher fracture resistance. The dominant failure pattern was repairable fracture, except for those with large cylindrical groups.

B. Photoelastic measurements

Asvanund, P, Morgano, SM. **Photoelastic stress analysis of different prefabricated post-and-core materials.** *Dent Mater J. 2011;30(5):684-90. Epub 2011 Sep 23.*

The purpose of this study was to investigate stress developed by a combination of a stainless steel post or a fiber-reinforced resin post with a silver amalgam core or a composite resin core. Two-dimensional photoelastic models were used to simulate root dentin. Posts (ParaPost XT and ParaPost-FiberWhite) were cemented with a luting agent (RelyX Unicem). Silver amalgam cores and composite resin cores were fabricated on the posts. Complete crowns were fabricated and cemented on the cores. Each model was analyzed with 2 force magnitudes and in 2 directions. Fringe orders were recorded and compared using ANOVA (p=0.05) and the Scheffe's test. With vertical force, no stress differences occurred among the 4 groups (p=0.159). With a 30-degree force, there was stress differences among the 4 groups (p<0.001). **Conclusions:** The combination of a fiber-reinforced post and composite resin core could potentially reduce stresses within the radicular dentin when angled loads are applied. **PDF**

*Cifuentes, I., Fernandez, A., Petrasic, L. et al **Photoelastic stress distribution for four endodontic post sytems.** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #2934, 2005 (www.dentalresearch.org)*

Objectives: Determine if the fabrication and technology of four post systems modify the stress distribution to canals. **Methods:** The stress distributing characteristics associated `with the installation and function of D. T. Light-Post (Quartz fiber, RTD, St Egreve, France)), EasyPost (Glass fiber, Dentsply), Reforpost (Angelus) and Unimetric Post (Steel post, Dentsply) as a control group were determined with a 2-dimensional photoelastic stress analysis using a circular polariscope. Standardized 11 mm in length canals were prepared in PSM-5 (Measurements Group, Raleigh ;N.C) photoelastic sheets material with increasing sizes acrylic drills. All the posts were cemented with resin cement (Bifix QM, Voco, Germany). Then the posts were loaded vertically and with a 26 degrees inclined load at 20, 30,40,50 and 60 kilograms. The posts were photographed (Olympus 5050 Digital Camera) by use of the circular polariscope in the loaded and unloaded state. Qualitative measurement of the number (magnitude) and the closeness (concentrate) of the fringes were made. **Results:** The steel preformed post showed the higher stress magnitudes at the vertical and lateral loading. It showed stress concentration at the apical and at each post thread. The pre-stressed fiber post at the vertical load showed the least magnitude and concentration of stress in the surrounding photoelastic material. At lateral loads fiber-glass EasyPost and pre-stressed quartz fiber post showed similar behaviors. **Conclusions:** Stress distribution surrounding post cemented in canals, done in photoelastic material, is related with the fabrication material and with the fabrication technology of the posts.

*Cifuentes, I., Fernandez, A., Sanchez, A. and Pavlov. P. **Stress distribution surrounding five endodontic posts** *J Dent Res, Vol 83 (Spec. Iss. A) Abstract #4084, 2004 (www.dentalresearch.org)*

Objectives: Determine if the cement interface thickness and fabrication material of five post system modify the stress distribution to flared canals. **Methods:** The stress distributing characteristics associated with installation and function of Cast Post (Ni-Cr), Para-Post (Steel post, Coltene-Whaladent), Integrapost (Titanium post, Premier), Mooser Post (Steel-post, Maillefer) and D.T. Light-Post (RTD, St Egreve, France) were determined with a two-dimentional photoelastic stress analysis using a circular polariscope (Photoelastic Inc).Standardized enlarged canals were prepared in PSM-5 (Measurements Group, Raleigh ;N.C) photoelastic sheets material with increasing sizes acrylic drills (Orico,Germany). All the posts were cemented with resin cement (Duo-Link, Bisco Inc).The cast post was made closely adapted to the canal walls and cemented with the same cement .Then the posts were loaded vertically and with a 35 degrees inclined load at 10,20 and 30 kilograms. Then the posts were photographed (Olympus 5050 Digital Camera) by use of the circular polariscope in the loaded and unloaded state. Qualitative measurement of the number (magnitude) and the closeness (concentrate) of the fringes were made. **Results:** The cast post with thinner cement interface showed the higher stress magnitudes at the vertical and lateral loading. All the metallic preformed post showed high stress concentration at the apical and cervical zones for the loads respectively .The fiber post at the vertical and lateral load showed the least magnitude and concentration of stress in the surrounding photoelastic material. **Conclusions:** The stress distribution surrounding posts cemented in flared canals, done in photoelastic material, is related with the fabrication material of the post and with the thickness of the cement interface.

Lopes, M.B., Bosso,K., Moura, S.K., Gonini-Júnior, A. **Photoelastic stress analysis of different endodontics posts.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 607, 2009. (www.dentalresearch.org)*

Objectives: This study analyze the stress distribution and severity produced by different endodontics posts (G1 – Metallic cast post, G2 – glass-fibre, G3 – carbon-fibre, G4 – metallic screw post, G5 - glass-fibre with resin reconstruction technique) at different loads (occlusal or 45-degrees). **Methods:** One human canine tooth has the canal prepared according to the glass-fibre and carbon-fibre manufacturers' instructions. The crown was removed and the reminiscent prepared for a total metallic-ceramic crown. The prepared tooth was moulded with polyvinyl-siloxane and duplicated in photoelastic resin (n=5 for each group). G1 was casted and cemented with zinc phosphate; G2 and G3 was cemented with resin cement and the core constructed in composite resin; G4

was inserted with an screwdriver and cemented with zinc phosphate; G5 have the glass-fibre post reconstructed in composite resin to copy the canal shape and then cemented with resin cement. A load of 10N was applied on the incisal, perpendicular to the core and at 45-degrees. The specimens were analysed with photoelastic equipment. A score of 0,25 was given to each colour of the fringe, totalling score 1 for a full fringe formation. A descriptive analysis was done. **Results:** At 45-degrees load, G1 showed score 1 at the first and middle third and 1.5 at the last third of the root; G2 and G3 score 0.75 at the last third; G4 score 1.5 around all the screws; G5 score 0,75 at the first third and score 1.5 at the last third. At occlusal load, G1 presents score 1 at the middle and last third of the root; G2 and G3 score 1 at the middle third; G4 score 1 around the screws; G5 score 1.5 at the first an last third. **Conclusions:** In general, glass-fibre and carbon-fibre groups showed less stress formation and a favourable stress location. Yamamoto, M., Miura, H., Okada, D., Masuoka, D., Komada, W. and Suzuki, C. **Photoelastic stress analysis in different types of post and core**, *Dent Res. Vol 86 (Spec. Iss. A) Abstract #2617, 2007 (www.dentalresearch.org)*

Objectives: The aim of this study was to compare three types of post and core systems and analyze the stress magnitude within the root. **Methods:** Two-dimensional photoelastic simulation models of endodontic treated upper central incisors were fabricated with epoxy resin sheets (6 mm of thickness). Models were 10 times the life size. The post and core systems were divided in three different types, build-up method using only composite resin (R), build-up method using composite resin in combination with a glass fiber post (R+F), and a cast post and core (C). The equivalent ratio of elastic modulus for composite resin, dentin, glass fiber post, and metal were considered for all the parts (5:1). The models were observed in a transmission polariscope with the same loading force (400 N) on 45 degrees palatal direction. The measured points were the buccal margin area of the root and the surrounding area of the apex of the post, which used to present the higher stress concentration area. The isochromatic fringe patterns and the stress distribution in the tooth simulation models were analyzed. **Results:** In the buccal margin area of the root, R, R+F and C showed 3.1 fringe order, 1.4 fringe order, and 2.4 fringe order, respectively. For the surrounding area of the apex of the post, R, R+F and C showed 0.45 fringe order, 0.80 fringe order, and 1.0 fringe order, respectively. **Conclusion:** The stress concentration in the buccal margin area of the root had a higher distribution, compared with the surrounding area of the apex of the post. Resin + Fiber post model had the lowest stress concentration in the buccal margin area of the root.

Zhang, WY, Shi, CX, et al**. Three-dimensional photoelastic stress analysis of roots restored with FRC posts and Ni-Cr alloy posts.** *J Dent Res. Vol 83 (Spec. Iss. B China), 2004 (www.dentalresearch.org)*

Objectives: Post-and-core is a perfect restoration method for residual crown or root of pulpless teeth. More and more emphasis has been placed on how to avoid tooth fracture and maintain esthetic appearance without reducing strength and retention. This study shows that the new developed fiber-reinforced composite post (FRC) used successfully for several years, because of their strength and relative flexibility, ease of placement or ease of removal. The purpose of this study was to analyze the effect of two modulus elasticity material posts on root stress distribution by using three-dimensional photoelastic analysis. **Methods:** The photoelastic models were divided into four groups according to posts material and loading. The roots stress distribution, which restored with FRC posts and Ni-Cr alloy posts, was analyzed by three-dimensional photoelastic analysis. **Results**: The material of posts influenced the root stress distribution significantly. The greater stress concentration was found at apex of Ni-Cr alloy posts with high modulus, the stress was evenly in FRC posts groups. **Conclusions:** The study concluded that the modulus of posts material influenced the root stress distribution significantly. The FRC posts which modulus was closed to teeth could protect roots from fracture.

C. Stress Distribution F. E. A.

Adanir, N., Belli, S. **Stress analysis of a maxillary central incisor restored with different posts.** *Eur J Dent 2007; 2:67-71*

Objectives: To evaluate the effects of different post materials on the stress distribution in an endodontically treated maxillary incisor. **Methods:** a pseudo 3-dimensional finite element model was created in a labiolingual cross-sectional view of a maxillary central incisor and modified according to five posts with different physical properties consisting of stainless steel, titanium, gold alloy, glass fiber (SnowPost/ Carbotech) and carbon fiber post (Composipost/RTD, St Egreve, France). A 200 newton force was then applied from 2 different directions; a) a vertical load on the incisal edge, and b) 45 degreee diagonal load above the cingulum location. Stress distribution and values were then calculated by considering the pseudo 3 dimensional von Mises stress criteria. **Results:** Under the 2 loading conditions, post made of steel showed greatest stress concentration at the post/dentin interface, followed by titanium, gold alloy, SnowPost and Composipost. However, Composipost, which elastic modulus was closer to dentin, produced higher rate of stress values at the cervical 1/3. **Conclusions:** Within the limitations of this simulated mechanical analysis, we can conclude that the physical characteristics of posts were important on stress distributions in post and core applications. Fiber posts revealed more balanced stress under functional forces. **PDF**

*Aggarwal, S, Garg, V. **Finite element analysis of stress concentration in three popular brands of fiber posts systems used for maxillary central incisor teeth**. *J Conserv Dent. 2011 Jul;14(3):293-6.*

Objectives:: To study the stress concentrations in endodontically treated maxillary central incisor teeth restored with 3 different fiberpost systems subjected to various oblique occlusal loads. **Methods:** FEM analysis was used to analyze stress concentrations generated in maxillary anterior teeth. Computer aided designing was used to create a 2-D model of an upper central incisor. Post systems analyzed were the DT Light Post (RTD, St Egreve France, Bisco, Inc), Luscent Anchor (Dentatus) & RelyX (3M-ESPE). The entire design assembly was subjected to analysis by ANSYS for oblique loading forces of 25N, 80N & 125 N. **Results:**: The resultant data showed that the RelyX generated the least amount of stress concentration. **Conclusions:** Minimal stress buildups contribute to the longevity of the restorations. Thus, RelyX by virtue of judicious stress distribution, is the better option for restoration of grossly decayed teeth. **PDF**

Al-Omiri MK, Rayyan MR, Abu-Hammad O. **Stress analysis of endodontically treated teeth restored with post-retained crowns: A finite element analysis study.** *J Am Dent Assoc. 2011 Mar;142(3):289-300.*

Background: The authors conducted a study to analyze the stress concentration areas in a tooth restored with a post-retained crown under various conditions. **Methods:** The authors constructed a three-dimensional finite element model describing a maxillary second premolar restored with an all-ceramic crown supported by a titanium post and a resin-based composite core. They applied static vertical and horizontal loads of 100 newton to the cusp tip of the crown and recorded Von Mises and tensile stress values. The variables investigated were the presence of the post, coronal and apical post extensions, post diameter, post shape, and post and core material. **Results:** The study results showed that horizontal loading generated higher levels of stress than did vertical loading. The greatest stress levels were concentrated at the cervical region and at the post-dentin interface in all models. Under both loads, a higher modulus of elasticity of the post material and a wider post diameter were associated with increased stress values at the post-dentin interface. Reduction of the post extension above the level of bone was associated with increased dentinal stresses near the apex of the post. **Conclusions:** Although endodontic posts provide retention for coronal restorations, they result in dentinal stress values higher than those of crowns without posts. Posts that had a similar modulus of elasticity to dentin and smaller diameters were associated with better stress distribution. Resting coronal restorations on sound dental tissues affected stress distribution more than did the core material or the length of the coronal post extension. **Clinical implications**: Many factors influence the distribution of stress within dentin and, consequently, the fracture resistance of teeth restored with post-retained crowns. Clinicians need to keep these factors in mind when performing endodontic procedures that involve placement of post-retained crowns to ensure optimal success. **PDF**

Albuquerque, R C, Polleto, LT, Fontana, RH, Cimini, CA. **Stress analysis of an upper central incisor restored with different posts**. *J Oral Rehabil. 2003 Sep;30 (9):936-43.*

Summary / conclusions: The effect of different anatomic shapes and materials of posts in the stress distribution on an endodontically treated incisor was evaluated in this work. This study compared three post shapes (tapered, cylindrical and two-stage cylindrical) made of three different materials (stainless steel, titanium and carbon fibre on Bisphenol A-Glycidyl Methacrylate (Bis-GMA) matrix).Two-dimensional stress analysis was performed using the Finite Element Method. A static load of 100N was applied at 45 degrees inclination with respect to the incisor's edge. The stress concentrations did not significantly affect the region adjacent to the alveolar bone crest at the palatine portion of the tooth,regardless of the post shape or material. However, stress concentrations on the post/dentin interface on the palatine side of the tooth root presented significant variations for different post shapes and materials. Post shapes had relatively small impact on the stress concentrations while post materials introduced higher variations on them. Stainless steel posts presented the highest level of stress concentration, followed by titanium and carbon/Bis-GMA posts.

Akoglu, B., Yildiz, B,. Cansiz, C., Ozkan, Y. , Kayabasi, O. **Effect of post material, cement and amount of coronal destruction**, *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 455, 2009. (www.dentalresearch.org)*

Objectives: Endodontically treated teeth are affected by a higher risk of biomechanical failure than vital teeth. A comparative study on the stress distribution of an endodontically treated maxillary incisor has been carried out by three dimensional stress analyses using the Finite Element Method. The role of post material and cement rigidity and amount of coronal destruction on reliability of endodontic restorations is discussed. **Methods:** A 3D FEM model of a central maxillary incisor was created. The following parameters were studied: 2 levels of coronal destruction (1- total loss of coronal dentin, 2- partial loss of coronal dentin with 2 mm surviving dentinal walls), 3 loading conditions(mastication, bruxism and impact), 3 different luting cements, 4 post materials (steel, titanium, glass fiber, zirconium posts) when present, and absence of post. In this study the validity of the FEM model was controlled by an in vitro test. Thirty recently extracted caries free, human maxillary central incisors with similar root sizes were divided into 6 groups. Endodontic treatment was subsequently performed and post core restorations were prepared and porcelain restorations were fabricated. Fracture strength and mode of failure was determined by universal testing machine. **Results:** As a result there were significant differences between post systems, cements ($p \leq 0.05$). The presence of 2 mm coronal dentin decreased the maximum stress values in all models. The stresses decreased with the post material in order of steel, zirconium, titanium, glass fiber. In functional loading, maximum equivalent stress mostly occurs at the vestibular side of the cement layer.

There was correlation between the results of FEM and fracture test results. **Conclusion:** FE analysis is a powerful tool in calculating stress distributions in complex structures. Minimum stress values were obtained with the glass fiber post bonded with an adhesive resin cement with low elastic modulus .

Ausiello, P, Franciosa, P, Martorelli, M, Watts, DC. **Mechanical behavior of post-restored upper canine teeth: a 3D FE analysis**. *Dent Mater. 2011 Dec;27(12):1285-94. Epub 2011 Oct 13.*

Objectives: The aim was to evaluate the stress distribution, comparing an anterior sound tooth with post-endodontic restored teeth under mechanical loading. **Methods:** A three-dimensional finite element analysis was performed based on micro-CT scan images of a maxillary canine. Twelve models with different crown properties and post-configurations were simulated. The model of the maxillary sound canine was also created and investigated. A load of 50N was applied at a 63° angle with respect to the longitudinal axis of the tooth on the palatal surface of the crown. Principal stresses were registered. Numerical FEA results were statistically analyzed to show the influence of post shape and crown materials. **Results:** All analyzed models (M1-M12) exhibited a high stress gradient, due to different material stiffnesses present at the various interfaces. The most uniform mechanical behavior of the investigated models, very similar to sound tooth, was the combination of a composite crown and a cylindrical or conical fiber-glass post. **Conclusions:** The results of this study facilitate informed clinical choice between possible material combinations in restorative procedures of endodontically treated anterior teeth.

Bolla, M., Laplanche,O., Leforestier, E., Muller-Bolla, M., **Influence of elastic modulus of posts on stress distribution** *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #2609, 2007 (www.dentalresearch.org)*

Objectives: fractures of restored pulpless teeth can be influenced by many factors, including type or design of the post, or the occlusal load and its direction. The purpose of this study is to use finite element analysis to investigate the effect of different posts used for restoring endodontically treated teeth according to different elastic moduli and direction of the occlusal load. Method: a 3-dimensional finite element model, including the periodontal ligament, was constructed in a mesio-distal cross sectional view of a mandibulary premolar. Tooth was fully restored with a cast crown, as occurs in clinical practice. The standard model was composed of 80000 elements and 130000 nodes. Elastic modulus and Poisson's ratio of different components, along with the coordinate and geometry of each node and element were entred into a computer. Four different posts (length: 14 mm – diameter : 1.2 mm ; 3 metallic : stainless, titanium, gold – 1 non-metallic : carbon fiber) were investigated according to three different composite core materials. The effect of a 300 MPa load on vertical, 30 degrees and 45 degrees oblique direction was tested. Analysis program (IDEAS, version n°6) was used to solve the stress analysis problem. **Results:** stress distribution in the root depends on the elastic modulus and on the direction of the occlusal load. Elastic modulus of the core is less significant than elastic modulus of the post. **Conclusions**: the effect of the post on stress distribution varies according to the direction of the load : in a vertical load, gold and carbon fiber posts generate lower stresses in the root than other metallic posts. In a 30 or 45 degrees oblique load, best results are obtained with a carbon-fiber post.

Bolla, M., Laplanche, O. et al. **Elastic modulus and stress distribution: finite element analysis.** *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #2933, 2005 (www.dentalresearch.org)*

Objective: Fractures of restored pulpless teeth can be influenced by many factors, including type or design of the post, or the occlusal load and its direction. The purpose of this study is to use finite element analysis to investigate the effect of different posts used for restoring endodontically treated teeth, according to different elastic moduli and the direction of occlusal load. **Methods:** a 3-dimensional finite element model, including the periodontal ligament, was constructed in a mesio-distal cross sectional view of a mandibular premolar. The tooth was fully restored with a cast crown, as occurs in clinical practice. The standard model was composed of 80000 elements and 130000 nodes. Elastic modulus and Poisson's ratio of different the components, along with the coordinate and geometry of each node and element were entered into a computer. Four different posts (length: 14mm, diameter: 1.2mm) 3 metallic (stainless, titanium gold) and one non-metallic (carbon fiber) were investigated according to three different composite core materials. The effect of a 300MPa load on vertical, 30 degrees and 45 degrees oblique was tested. Analysis program (IDEAS, Version 6) was used to organize the stress analysis data. **Results:** Stress distribution in the root depends on the elastic modulus and the direction of the occlusal load. Elastic modulus of the core is less significant than the elastic modulus of the post. **Conclusions:** The effect of the post on stress distribution varies according to the direction of the load. In a vertical load, gold and carbon fiber posts generate lower stresses in the root than other metallic posts. In a 30 or 45 degree oblique load, the best results are obtained with a Carbon fiber post.

Borcic, J., Catic, A., Smojver, I., Antonic., R., Petricevic, N., and V. Reljic, **Stress distribution in glass fiber vs cast post and core.** *Dent Res. Vol 86 (Spec. Iss. A) Abstract #2621, 2007 (www.dentalresearch.org)*

Objectives: Endodontically treated teeth become brittle as a result of moisture loss and have a greater incidence of fracture than vital and healthy teeth. The difference between the elastic modulus of dentin and the post material may be a source of stress in the root structures. The aim of the study was to analyse the mechanical behaviour of a teeth restored with prefabricated glass fiber posts and composite core vs cast post and core through 3D finite element analysis. **Methods:** Models have more than 1,5 million

elements and an average loading force of 200 N was used to simulate biting forces in the two different occlusal conditions. First condition represents so called normal occlusion with tripodal occlusal contact. Second condition represents malocclusion with single contact on the palatal cusp. The load vectors were applied in the direction normal to the surface in order to simulate the contact with antagonistic teeth. **Results:** Endodontic posts take some of the stresses on themselves and values are smaller on the surface of the tooth. In the case of normal occlusion stress distribution is the same for sound and restored tooth, dissimilarity exists in the values of stresses. Significantly higher tensile stress values were recorded for the cast post and core restored tooth. At the root furcation, tensile stress appeared only in the restored tooth. In the case of normal occlusion, tensile stress at root furcation occurs only in the model with cast post and core. **Conclusions:** Cast posts resulted in significantly higher stress values. Tensile stresses are much harmful for the tooth tissue and this type of stress occurs at the root furcation only in the restored tooth, especially in the cast post and core.

Borcic, J. et al. **Finite element study of the glass fiber endodontic posts.** *J Dent Res. Vol 83 (Spec. Iss. A) Abstract #0530, 2004 (www.dentalresearch.org)*

Objectives: Post and core applications are generally used in the restoration of endodontically treated teeth. The stress distribution during masticatory function in a tooth restored with a post and core can cause root fracture. The different mechanical behavior of post and dentine is a critical parameter for the load transmission. In order to minimize the rigidity difference between the post and the dentine, a new kind of post was developed. The aim of this study was to analyze the mechanical behavior of a new polymeric composite post reinforced with glass fibers. A natural tooth was considered as a reference model. **Methods:** The 3D finite element method (FEM) was selected to perform the stress analysis of the two-rooted first maxillary premolar restored with glass fiber posts. Composite resin was used as the core material and full porcelain crowns covered the model. Four noded tetrahedral were applied in the description of the tooth morphology, resulting in 1,684,512 elements and 246,510 nodes with 739,539 degrees of freedom. A total force of 200N was applied. **Results:** The greatest stresses were observed in the palatal cervical region (-16.126MPa) and in the intraradicular parts of the post (-23.898MPa). In the cervical region, the mean high-intensity compressive stress areas were more extensive in the natural tooth (-175.222 MPa). **Conclusions:** The glass fiber composite post induces a stress field similar to that of the natural tooth, except in the cervical region, where the tooth has higher compressive stresses.

Chuang, S-F, Chang, C-H, Su, K-C, Yaman, P. **Effect of post length and material on periodontally involved teeth .** *J Dent Res. Vol 85 (Spec. Iss. B) Abstract #0006, 2006***.** *(www.dentalresearch.org)*

Objective: To investigate the stress distribution of periodontally involved teeth restored with different posts using finite element analysis. **Methods:** 2-D models of a maxillary central incisor consisting of a PFM crown, composite core, parallel post, dentin, gutta percha, periodontal ligament, and cortical/trabecular bone were constructed using ANSYS v9.0 software. The posts tested were stainless steel (SS), carbon fiber (CF), and glass fiber (GF) at 10mm and 5mm lengths into the root canals. The alveolar bone level was set either as intact periodontium or with bone loss even with the apical end of short post. All materials were assumed to be linearly elastic and isotropic except CF and GF posts which were orthotropic. Teeth were subjected to two different loads: the first a 70N force on the incisal tip; the second a 100N force on the lingual surface of crown at a 145 degree angulation. **Results:** With the 70N load the stress distribution patterns were similar among the groups. For the 100N load at 145 degrees, the models representing periodontal bone loss showed higher von Mises stress over the middle part of root periphery and around the post ends compared to the intact periodontium groups. In the intact periodontium groups, the stress around the crown margins was higher than the middle of the root. The SS post exhibited higher stress levels than the other posts only around the apical end of the post. The SS/5mm group with periodontal bone loss exhibited the greatest stress (334 MPa) on the dentin around the ends of posts. **Conclusion:** Teeth with posts and periodontal bone loss generate higher stress concentrations with an increased risk of root fracture. The major difference in stress distribution between rigid and non-rigid posts is primarily around the apical ends of the posts.

Coelho, CS, Biffi, JC, Silva, GR, Abrahão, A, Campos, RE, Soares, CJ**. Finite element analysis of weakened roots restored with composite resin and posts.** *Dent Mater J. 2009 Nov;28(6):671-8*.

Finite element analysis (FEA) was used to investigate the influence of different post systems on the stress distribution of weakened teeth under oblique-load application. A maxillary central incisor root obtained from a sound tooth was weakened by partial removal of dentin inside the root canal. Seven two-dimensional numerical models, one from the sound tooth and six from the weakened root restored with composite resin and post systems were created as follows - ST: sound tooth; CPC: cast CuAl post and core; SSP: stainless steel post + composite core; GP: fiberglass + composite core; CP: carbon fiber + composite core; ZP: zirconium dioxide post + composite core; TP: titanium post + composite core. The numerical models were considered to be restored with a leucite-reinforced all-ceramic crown and received a 45 masculine occlusal load (10 N) on the lingual surface.All the materials and structures were considered linear elastic, homogeneous, and isotropic, with the exception of fiberglass and carbon fiber posts which assumed orthotropic behavior. The numerical models were plotted and meshed with isoparametric elements, and the results were analyzed using von Mises and Sy stress criteria. When compared with the sound tooth, FEA revealed differences in stress distribution when post systems were used. Among the restored teeth, the use of CPC, SSP, ZP, and TP resulted in higher stress concentration in the post itself when compared to GP and CP. Therefore, results from the FEA images suggested that the use of non-metallic post systems could result in improved mechanical behavior for the weakened restored teeth. **PDF**

Duret, B., Duret, F., and Reynaud, M. **Long-life physical property preservation and postendodontic rehabilitation with the Composipost.** *Compendium. 17: S50-S56, 1996.*

Abstract/conclusions: Most coronal radicular reconstructions are made of cast inlay core metals or prefabricated metal posts covered in composite. The differences in the mechanical properties of these elements create a heterogeneous mass with inconsistent mechanical behavior. Studies using the Finite Element Method have shown the biomechanical disturbances casued by the inclusion of materials with a modulus of elasticity that is superior to that of dentine (ie, nickel, chrome, zircon, etc). The use of materials with a modulus of elasticity close to that of dentine does not disturb the flow of stress inside the root. To our knowledge, only a composite material structured with programmable mechanical properties would be capable of producing both high mechanical performance and a modulus of elasticity adapted to dentine values. The C-POST, made of carbon epoxy, accommodates the demands of the dentine, as well as the in vitro stress linked to the prosthesis. The internal structure, consisting of long high-performance carbon fibers, unidirectionally and equally stretched, confers a totally original behavior that is adapted to clinical objectives. In addition, the C-POST/Composipost (RTD, St Egreve, France) has a fracture resistance superior to most metals. **PDF**

Eraslan, O, Aykent, F, Yücel, MT, Akman, S. **Finite element analysis of the effect of ferrule height on stress distribution at post-and-core-restored all-ceramic anterior crowns.** *Clin Oral Investig. 2008 Aug 12.*

The purpose of this study was to compare the effect of ferrule with different heights on the stress distribution of dentin and the restoration-tooth complex, using the finite element stress analysis method. Three-dimensional finite element models simulating an endodontically treated maxillary central incisor restored with an all-ceramic crown were prepared. Three-dimensional models were varied in their ferrule height (NF: no ferrule, 1F: 1-mm ferrule, and 2F: 2-mm ferrule). A 300-N static occlusal load was applied to the palatal surface of the crown with a 135 degrees angle to the long axis of the tooth. In addition, two post and core materials with different elastic modulus were evaluated. The differences in stress transfer characteristics of the models were analyzed. Maximum stresses were concentrated on force application areas (32.6-32.8 MPa). The stress values observed with the use of a 2-mm ferrule (14.1/16.8 MPa) were lower than the no-ferrule design (14.9/17.1 MPa) for both the glass fiber-reinforced and zirconium oxide ceramic post systems, respectively. The stress values observed with zirconium oxide ceramic were higher than that of glass fiber-reinforced post system. The use of a ferrule in endodontically treated teeth restored with an all-ceramic post-and-core reduces the values of von Mises stresses on tooth-restoration complex. At rigid zirconium oxide ceramic post system, stress levels, both at dentin wall and within the post, were higher than that of fiber posts. **PDF**

Ferrari, M, Sorrentino, R, Zarone, F, Apicella, D, Aversa, R, Apicella, A. **Non-linear viscoelastic finite element analysis of the effect of the length of glass fiber posts on the biomechanical behaviour of directly restored incisors and surrounding alveolar bone.** *Dent Mater J. 2008 Jul;27(4):485-98*

The study aimed at estimating the effect of insertion length of posts with composite restorations on stress and strain distributions in central incisors and surrounding bone. The typical, average geometries were generated in a FEA environment. Dentin was considered as an elastic orthotropic material, and periodontal ligament was coupled with nonlinear viscoelastic mechanical properties. The model was then validated with experimental data on displacement of incisors from published literature. Three post lengths were investigated in this study: root insertion of 5, 7, and 9 mm. For control, a sound incisor model was generated. Then, a tearing load of 50 N was applied to both sound tooth and simulation models. Post restorations did not seem to affect the strain distribution in bone when compared to the control. All simulated post restorations affected incisor biomechanics and reduced the root's deforming capability, while the composite crowns underwent a higher degree of deformation than the sound crown. No differences could be noticed in incisor stress and strain. As for the influence of post length, it was not shown to affect the biomechanics of restored teeth. **PDF**

Garbin, CA, Spazzin, AO, Meira-Júnior, AD, Loretto, SC, Lyra, AM, Braz, R. **Biomechanical behaviour of a fractured maxillary incisor restored with direct composite resin only or with different post systems.** *Int Endod J. 2010 Dec;43(12):1098-107. doi: 10.1111/j.1365-2591.2010.01782.x. Epub 2010 Aug 18.*

Aim: To compare stress distribution between a fractured maxillary central incisor restored with direct composite resin only (CR) or associated with different post materials, using finite element analysis. **Method:** A three-dimensional model of a sound maxillary central incisor and supporting structures was constructed, using data from the dental literature. Changes were made in the crown region to create a tooth with a restored crown fracture. A composite resin restoration only and restorations associated with different tapered post systems (glass fibre, carbon fibre, titanium and zirconia ceramic) were also evaluated, resulting in six experimental models. A static chewing pressure of 2.16 Nmm(-2) was applied to two areas of the palatal surface of the tooth. Stress distribution was analysed under a general condition and in the structures of the models separately. **Results:** The maximum stresses were concentrated as follows: at the cemento-enamel junction in the model with a sound maxillary central incisor, restored with CR and with a composite resin restoration associated with fibre posts; in the enamel at the post-enamel interface on the palatal surface of the model with a titanium post; and in the post of the model with zirconia ceramic post. **Conclusions:** None of the res-

torations evaluated was able to recover the stress distribution of the sound tooth. The models restored with composite resin associated with a glass or carbon fibre post had similar stress distributions to that of the model restored with CR. The different post materials were shown to have a substantial influence on stress distribution, with less stress concentration when fibre posts were used. **PDF**

Garhnayak, L, Parkash, H, Sehgal, DK, Jain, V, Garhnayak, M. A **comparative study of the stress distribution in different endodonticpost-retainedteeth with and without ferrule design-a finite element analysis**. *ISRN Dent. 2011;2011:102329. Epub 2011 Jun 14.*

Purpose: To analyze the stress distribution in an endodontically treated maxillary central incisor restored with various post-core systems and assess the benefit of ferrule using finite element analysis. **Methods:** Twelve models with metal ceramic crown were created based on the combination of three types of post-core systems (titanium post-composite resin core, nickel-chromium post-core, and fiber reinforced composite resin post-composite resin core), two varieties of posts (tapered, parallel), and with or without ferrule. 100 N load was applied in three directions and the von Mises stress was compared. **Results:** Ferrule made no difference in stress distribution for the titanium and nickel-chromium posts, though it showed some stress reduction in fiber-reinforced composite resin posts. Nickel-chromium cast post-core transmitted the least amount of stresses to the dentin despite producing the maximum stress. **Conclusions:** Incorporation of ferrule offered some degree of stress reduction in nonmetal post, and it increased the stresses within cervical dentin.

Jongsma, LA, Ir Nde, J, Kleverlaan, CJ, Feilzer, AJ. **Reduced contraction stress formation obtained by a two-step cementation procedure for fiber posts**. *Dent Mater. 2011 Jul;27(7):670-6. Epub 2011 Apr 22.*

Objectives: in a previous study, a 60% increase in push-out strength was obtained in vitro with a two-step cementation of fiber posts, a procedure equivalent to the layering technique of composite restorations. The aim of this study is to find the rationale for this increase in push-out strength with finite element analysis (FEA). **Methods:** FEA models were created of the push-out test set-up of fiber posts cemented according to a one-step and two-step procedure and of the complete root with post. The failure loads of glass-fiber posts cemented with RelyX Unicem as obtained in a previous study were used as the load in the push-out FEA models. For the complete root model, a load of 100N was used. The stresses due to the shrinkage of the cement layer and the applied load were determined for the one-step and two-step procedure of the push-out test specimens and for the one-step procedure of the complete root. **Results:** Even though the load in the two-step push-out model was 60% higher compared to the one-step model, the combined stresses were comparable. The stresses due to shrinkage alone in the complete root approached or exceeded the bond strength of resin cements to dentin in the coronal and apical areas. **Significance:** FEA of this test set-up explains the results of the in vitro study. Two-step cementation of fiber posts leads to a decrease in internal stresses in the restoration which results in higher failure loads and possibly in less microleakage.

Lanza,' A., Aversa, R.,' Rengo, S., Davide, Apicella, D., Apicella, A.. **3D FEA of cemented steel, glass and carbon posts in a maxillary incisor** *Dent Mater. 2005 Aug; 21(8):709-15*

Objectives: A comparative study on the stress distribution in the dentine and cement layer of an endodontically treated maxillary incisor has been carried out by using Finite Element Analysis (FEA). The role of post and cement rigidity on reliability of endodontic restorations is discussed. **Methods:** A 3D FEM model (13,272 elements and 15,152 nodes) of a central maxillary incisor is presented. A chewing static force of 10 N was applied at 125° angle with the tooth longitudinal axis at the palatal surface of the crown. Steel, carbon and glass fiber posts have been considered. The differences in occlusal load transfer ability when steel, carbon and glass posts, fixed to root canal using luting cements of different elastic moduli (7.0 and 18.7 GPa) are discussed. **Results and significance:** The more stiff systems (steel and carbon posts) have been evaluated to work against the natural function of the tooth. Maximum Von Mises equivalent stress values ranging from 7.5 (steel) to 5.4 and 3.6 MPa (respectively, for carbon posts fixed with high and low cement moduli) and to 2.2 MPa (either for glass posts fixed with high and low cement moduli) have been observed under a static masticatory load of 10 N. A very stiff post works against the natural function of the tooth creating zones of tension and shear both in the dentine and at the interfaces of the luting cement and the post. Stresses in static loading do not reach material (dentine and cement) failure limits, however, they significantly differ leading to different abilities of the restored systems to sustain fatigue loading. The influence of the cement layer elasticity in redistributing the stresses has been observed to be less relevant as the post flexibility is increased. **PDF**

Martins, V., Silva, C., Veríssimo, C., Soares, C., Menezes, M., Santos-Filho, PC. **Impact test with different post systems: finite element analysis.,** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #3247, 2017(www.dentalresearch.org)*

Objectives: The aim of this study was to evaluate the influence of different post systems in deformation of endodontically treated teeth on impact test. **Methods**: A tooth restored with Cast Post and Core (CPC), a tooth restored with Glass Fiber Post (GFP) and healthy tooth (HT) were generated using a two-dimensional model. A non-linear dynamic analysis was used to simulate the impact test, where a rigid object model reaches a speed of 1 m/s^{-1}. Forty roots of bovine incisors were endodontically treated and randomly divided into two groups (n = 20) according to the type of post to be restored: CPC and GFP. The crowns were standardized. Strain gauges were attached to the buccal root region subjected to the impact test at different angles (n = 10): 90 ° and 45 °, directed in the vestibular center of the crown. **Results**: The model with CPC showed more strain at the root dentin than model

restored with GFP, but none of the two models was similar to the model of the healthy tooth. When comparing the strain within the root, GFP obtained higher values than CPC model. For the strain gauge test there was no significant difference in the pattern of strain/stress between the different post systems and test angles (P = 0,478). **Conclusions**: The GFP delivery strain along the root more closely of HT and inside its structure than CPC. Although they have different properties, the laboratory tests did not show significant differences.

Mezzomo, Luis André, Corso, Leandro; Marczak, Rogério José, Rivaldo, Elken Gomes. **Three-dimensional FEA of effects of two dowel-and-core approaches and effects of canal flaring on stress distribution in endodontically treated teeth**. *Journal of Prosthodontics, Volume 20, Number 2, February 2011 , pp. 120-129(10)*

Purpose: The aim of this 3D finite element analysis (FEA) was to assess stress distribution and levels in endodontically treated teeth restored with two dowel-and-core systems with differing root canal configurations. **Methods:** Four 3D finite element models of a laser-digitalized maxillary central incisor embedded in alveolar bone were created. Internal morphology data and mechanical properties of the materials were obtained from the literature. Models included a (1) sound tooth (control) versus an endodontically treated maxillary central incisor with a crown ferrule preparation with two restorative approaches of a ceramic crown over a (2) gold alloy dowel-and-core or (3) glass-fiber dowels with composite cores (4) the latter with a flared root canal. A 100 N static load was applied in the center of the palatal surface at a 45° angle, and the stress distribution pattern was analyzed using ANSYS® software. **Results:** In Model 1 (control), maximum stresses occurred at the coronal third of the buccal (2.32×10^7 Pa) and palatal aspects of dentin. The stress peak value of the model (2.45×10^7 Pa) occurred on the palatal aspect of the enamel at the level of the cementoenamel junction. With the insertion of dowels with thin cement layers (Models 2 and 3), stress concentrations in radicular dentin decreased, while they increased in the dowel/cement/dentin interface. These models exhibited the greatest stress peak values in the incisal margin of the gold alloy core (18.9×10^7 Pa) and in the cement layer (4.7×10^7 Pa). In Model 4, stress peak value was observed in the porcelain crown (4.62×10^7 Pa), and there was no stress concentration inside the cement layer. **Conclusions:** Within the limits of this study, the results suggest that the use of dowels and cements with mechanical properties similar to those of dentin, and an increased cement layer thickness, results in mechanical behavior similar to the physiological behavior of a sound tooth.

Nakamura, T, Ohyama, T, Waki, T, Kinuta, S, Wakabayashi, K, Mutobe, Y, Takano, N, Yatani, H. **Stress analysis of endodontically treated anterior teeth restored with different types of post material**. *Dent Mater J. 2006 Mar;25(1):145-50*

Finite element analysis was performed to evaluate stress distribution in maxillary central incisors treated endodontically and restored with a post and an all-ceramic crown. Tensile stress at tooth root was analyzed using two-dimensional finite element models with different post diameters and lengths. One post length was 1/3 of the root (short), while the other was 2/3 of the root (long); one post diameter was 1/3 of the root (narrow), while the other was 2/3 of the root (wide). The following combinations were used for posts and cores: gold alloy cast post and core, commercial stainless steel post and resin core, and fiber post and resin core. Results showed that the fiber post produced less stress on the root dentin around the post tip than did the metal posts. This finding thus suggested that to reduce the stresses that cause root fracture, a long, thin fiber post should be used.

*Nothdurft, FP, Seidel, E, Gebhart, F, Naumann, M, Motter, PJ, Pospiech, PR., **Influence of endodontic posts on the fracture behavior of crowned premolars with class II cavities**. *J Dent. 2008 Apr;36(4):287-93. Epub 2008 Feb 21.*

Aim: The aim of the study was to evaluate the influence of different posts and types of cementation on the fracture load and fracture mode of crowned, endodontically treated premolars with class II cavities in an ex vivo setting. **Methods:** Forty-eight single-rooted human premolars were endodontically treated and prepared with standardized MO (mesio-occlusal) cavities and a circular chamfer preparation. Eight teeth each received either no posts or were restored with screws (BKS), glass fiber posts (DentinPost), or quartz fiber posts (D.T. Light-Post SL; RTD, St Egreve, France). Sixteen teeth were restored with zirconium dioxide posts (CeraPost). BKS-screws and eight zirconium dioxide posts were cemented conventionally with glass ionomer cement; Panavia F was used for all others. The specimens were restored with composite cores and crowns cast from a non-precious metal. Eight sound premolars served as the controls. After thermomechanical fatigue testing, the samples were loaded until fracture occurred at an angle of 45 degrees. All specimens were evaluated for fracture lines. **Results:** The sound teeth showed the significant highest fracture load (792.50+/-210.01N). Conventionally cemented zirconium dioxide posts showed the lowest fracture load (327.00+/-45.84N); the highest fracture load occurred with quartz fiber posts (421.75+/-90.19N). Only the difference between these two groups was statistically significant. With glass fiber posts and conventionally cemented zirconia posts, restored teeth failed mostly in an "unfavourable" mode. **Conclusions:** With respect to the fracture load, there was no statistical difference between the restoration of non-vital premolars with class II cavities with crowns and posts or crowns alone. **PDF**

Okamoto, K, Ino, T, Iwase, N, Shimizu, E, Suzuki, M, Satoh, G, Ohkawa, S, Fujisawa, M. **Three-dimensional finite element analysis of stress distribution in composite resin cores with fiber posts of varying diameters.** *Dent Mater J. 2008 Jan;27(1):49-55*.

Using three-dimensional finite element analysis (3D-FEA), stress distributions in the remaining radicular tooth structure were investigated under the condition of varying diameters of fiber post for fiber post-reinforced composite resin cores (fiber post and core) in maxillary central incisors. Four 3D-FEA models were constructed: (1) fiber post (ø1.2, ø1.4, and ø1.6 mm) and composite

resin core; and (2) gold-cast post and core. Maximum stresses in the tooth structure for fiber post and core were higher than that for gold-cast post and core. In the former models, stresses in the tooth structure as well as in the composite resin were slightly reduced with increase in fiber post diameter. These results thus suggested that to reduce stress in the remaining radicular tooth with a large coronal defect, it is recommended to accompany a composite resin core with a fiber post of a large diameter.

Oliviera, L.C.A., Candido, M.S.M., Duarte, S., Oliviera, S.A.G., **Comparative study of stress distribution in upper incisors; biometric behavior of post systems**. *AADR Abstract #0548, 2003 (www.dentalresearch.org)*

Objective: this work proposes a study about the distribution of mechanical stresses in the radicular dentin restored with different post systems, by means of Photoelastic and Finite Element techniques. This analysis is conducted for the following post systems: carbon fiber, fiberglass, zirconium, stainless steel, titanium and cast metal (Cu-Al alloy) and the healthy tooth (control). The computer analysis and numerical results were validated by laboratory experimental data (Photoelastic). **Methods:** For this purpose, representative 2-dimensional models were of the upper central incisor were built for both methods. These models were subject to a 100N load applied at the tip of the crown, at 45^0 from the axis along the tooth. These results are expressed in terms of the Von Mises and Sy stresses and the fringe order, for the Finite Element and photoelastic methods, respectively. **Results:** Through the analysis of these results, it can be concluded that significant stress distributions arise between the 6 different post systems tested, so that those made of zirconium, stainless steel, titanium and cast metal produced high stress concentration at the post/dentin interface region. In the cases of carbon fiber and fiberglass, on the other hand, the stress distribution along the radicular surface is uniform, lacking stress concentration areas. **Conclusion:** The zirconium, stainless steel, titanium and cast metal posts present mechanical properties which are different from those of the tooth structure, resulting in significant alterations over the mechanical behavior of the dental structure. The non-metallic posts comply more satisfactorily with the requirements necessary to provide a mechanical behavior more similar to that of the dental structure, the compatibility among the mechanical properties found in these systems and the dentin providing a biometric behavior, reducing the risk of failure or fracture of the root.

Okada, D, Miura, H, Suzuki, C, Komada, W, Shin, C, Yamamoto, M, Masuoka, D. **Stress distribution in roots restored with different types of post systems with composite resin.** *Dent Mater J. 2008 Jul;27(4):605-11*

Although composite resin core is used with various types of prefabricated posts, it remains unclear which kind of material is most suitable for the post. The aim of this study was to evaluate the influence of prefabricated posts on the stress distribution within the root by finite element analysis. Posts and cores were built up with composite resin and four types of prefabricated posts: two types of glass fiber posts (GFP1, GFP2) with low and high Young's moduli, a titanium post (TIP), and a stainless steel post (SSP). In all models, stress distribution during function was calculated. There were differences in stress concentration at the root around the end of posts. The magnitudes of stress for GFP1, GFP2, TIP, and STP were 8.7, 9.3, 11.7, and 13.9 MPa respectively. Given the results obtained, GFP1 was the most suitable material for post fabrication since this model showed a lower stress value. It would therefore mean a lower possibility of root fracture. **PDF**

Okada, D., Miura, H., Suzuki, C., Komada, W., Yamamoto, M., Masouka, D., Shin, C. **Stress distribution in root restored with different post systems .** *J Dent Res 85, (Special Issue B) #0011, 2006 (www.dentalresearch.org)*

Objective: Composite resin core materials in conjunction with various kinds of prefabricated posts are gaining in popularity. However, it is not yet clear, which kind of material is most suitable for the post. The aim of this study was to evaluate the influence of the prefabricated post on stress distributions in an abutment tooth restored with composite resin by 3-dimensional finite element analysis. **Methods:** Four 3-dimensional finite element models of an endodonticaly treated premolar were made. In these four models, posts and cores were built up with composite resin and four types of prefabricated post; glass fiber post (GFP), Titanium post (TIP), Zirconia post (ZRP), and Stainless steel post (STP). In all the models, an occlusal force similar to chewing beef jerky, was applied to the center of occlusal surface (lingual direction: 24N,distal direction:29N, apical direction:164N), which was measured with a small 3-dimensional occlusal force meter. Then Von Mises stress distributions within the root were calculated. **Results:** In all models, there were similar distributions of stress concentration at the apical area. However, in the dentin of the root around the end of the prefabricated posts, there were differences in stress concentration. The magnitudes of stress in this area for GFR, TIP, ZRP and STP were 11.5 Mpa, 12.6 MPa, 12.0 MPa, and 14.9 MPa respectively. **Conclusion:** Within the limitations of this experiment, GFR was indicated to be most suitable since this model showed lower stress values, which means less possibility of root fracture.

Okada, D., Miura, H., Suzuki, C., Komada, W., Yamamoto, M., Masuoka, D., Shin, C. **Stress distribution in root with different post and core systems.** *J Dent Res 87, (Special Issue A) #0336, 2008 (www.dentalresearch.org)*

Objective: Root fracture is one of the most disturbing problems for dentists. Especially, sometime vertical or horizontal root fracture occurs in the abutment teeth with flared post hole. The aim of this study was to evaluate the influence of three kinds of post system on stress distributions in an abutment tooth had flared post hole by 3-dimensional finite element analysis. **Methods:** Three types of 3-dimensional finite element models of endodontically treated premolar with flared post hole were made. In each model, posts and cores were built up with composite resin with prefabricated stainless steel post (SSP), composite resin with glass fiber post (GFP), and cast post and core (CPC). In all models, same occlusal force, which were measured with a small 3-dimensional

occlusal force meter during chewing beef jerky in vivo, were applied to the center of occlusal surface (lingual direction: 24N,distal direction:29N, apical direction:164N). Then Von Mises stress within the root dentin, composite resin around two kinds of prefabricated post and luting agent around the end of CPC were calculated. **Results:** The magnitude of stress at the root dentin around the end of post for SSP, GFP, and CPC were 12.8 MPa, 11.1 MPa, and 13.6 MPa, respectively. On the other hand, the magnitude of stress of composite resin around the two kinds of prefabricated post (SSP, GFP) and luting agent around the end of CPC were 36.9 Mpa, 11.7 MPa, and 26.3 MPa, respectively. **Conclusion:** Within the limitation of this experiment, GFP thought to be most suitable for endodonticall treated teeth with flared post hole, since this model showed lower stress value within the root dentin and composite resin around the end of prefabricated post, which means less possibility of root fracture.

Pegoretti A, Fambri L, Zappini G, Bianchetti M. **Finite element analysis of a glass fibre reinforced composite endodontic post.** *Biomaterials. 2002 Jul;23(13):2667-82*

In this work the mechanical response to external applied loads of a new glass fibre reinforced endodontic post is simulated by finite element (FE) analysis of a bidimensional model. The new post has a cylindrical shape with a smooth conical end in order to adequately fit the root cavity, and to avoid edges that could act as undesired stress concentrators. Mechanical data obtained by three-point bending tests on some prototypes fabricated in the laboratory are presented and used in the FE model. Under various loading conditions, the resulting stress component fields are hence compared with those obtained in the case of two commercial endodontic posts (i.e. a cast metal post and a carbon fibre post) and with the response of a natural tooth. The gold cast post-and-core produces the greatest stress concentration at the post-dentin interface. On the other hand, fibre-reinforced composite posts do present quite high stresses in the cervical region due to their flexibility and also to the presence of a less stiff core material. The glass fibre composite shows the lowest peak stresses inside the root because its stiffness is much similar to dentin. Except for the force concentration at the cervical margin, the glass fibre composite post induces a stress field quite similar to that of the natural tooth. **PDF**

Saad, M.C.M., Takamatsu, F. A., Daniel, G. B. Ortega, V. L., Miranda, M. E., Teixeira, M. **The influence of material and design post on stress distribution.** *J Dent Res. Vol 88 (Spec. Iss. B) Abstract #2187, 2010 (www.dentalresearch.org)*

Objective: Analyze the influence of the amount of root dentin and different materials and diameters in post (cast gold core and fiber glass post) in the restored with 2D finite element analysis. **Methods:** Four virtual bidimensional models with a maxillary central incisor restored with post and core and with all-ceramic crown contacting against a mandibular central incisor were made. A 100 N load was applied into the maxillary incisor by the inferior incisor. The analysis was made considering a strain plain and all the structures were considered as homogeneous, isotropic and with linear elastic behavior as simplifying hypothesis. The data were analyzed with von Mises criteria and with tensile-compressive strain. **Results:** The most variable data were found in the apical area of the post, differing fiberglass from gold, showing that the fiberglass distribute better the strain along the post while the gold concentrate stress in the end of the post. **Conclusion:** It was concluded that there was no significant difference regarding stress distribution in the surrounding bone for the models analyzed. However, the groups with the gold core restoration showed higher stress concentration, which may indicate higher predisposition for fractures.

Samilee, P., Arunpraditkul, S., Dechaumphai, P. **Finite element analysis of various post and core restorations in teeth with flared root canal.** *J Dent Res. Vol 82 IADR Abstract #1936, 2003 (www.dentalresearch.org)*

Objectives: Endodontically treated teeth with flared root canal are frequently found for many reasons and the prognosis of post and core restoration are also unpredictable. Reinforcing techniques that weaken the tooth had been introduced, however, the suitable methods are still questioning. The aim of this study is to investigate the stress distribution in root dentin and restorative materials. **Methods:** The 2 –dimensional Finite Element models of flared root canals (Maxillary central incisors) with ten restorative techniques were performed, using MSC/Nastran for Windows. Three evaluated parameters: reinforcing or non-reinforcing the flared root canal, reinforcing materials (composite resin and reinforced glass ionomer) and the post materials (gold alloy type III, Ni-Cr alloy, stainless steel, and carbon fiber) were investigated. All materials were assumed to be homogeneous, isotropic, linearly elastic. The load (150N) was applied on the lingual surface of metal-ceramic crown; 130 degrees to the tooth axis. **Results:** The results showed that maximal tensile stress in dentin were reduced in the reinforcing models. Reinforcement with composite resin provided less maximum tensile strength than that with reinforced glass ionomer. Higher elastic modulus of posts, such as Ni-Cr alloy showed more maximum tensile stress at post apex, but less stress concentration at flared dentin compared with posts with lower elastic modulus. **Conclusions:** From this FEA study, reinforcement of flared root canal with composite resin and carbon fiber post showed favorable stress distribution in restoring the teeth with flared root canal.

Silva, N.R., Castro, C.G., Santos-Filho, P.C., Silva, G.R., Campos, R.E., Soares PV, Soares CJ. **Influence of different post design and composition on stress distribution in maxillary central incisor: Finite element analysis**. *Indian J Dent Res. 2009 Apr-Jun;20(2):153-8.*

Background: Post design and material has very important effects on dentinal stress distribution since the post placement can create stresses that lead to root fracture. **Methods:** In this study we use finite element analysis (FEA) to evaluate stress distribution on endodontically treated maxillary central incisors that have been restored with different prefabricated posts. Six models were

generated from the image of anatomical plate: Four metallic posts (ParaPost XH, ParaPost XT, ParaPost XP, and Flexi-Flange) and one fiberglass post (ParaPost Fiber Lux). The sixth model was a control-a sound maxillary central incisor. We used CAD software and exported the models to ANSYS 9.0. All the materials and structures were considered elastic, isotropic, homogeneous, and linear except the fiberglass post which was considered orthotropic. The values for the mechanical properties were obtained by a review of the literature and the model was meshed with 8-node tetrahedral elements. A load of 2N was applied to the lingual surface at an angle of 135 degrees. **Results**: The stress results were recorded by shear stress and von Mises criteria; it was observed that there was no difference for stress distribution among the titanium posts in the radicular portions and into posts. There was higher stress concentration on the coronary portion with the titanium posts than with the glass fiber post. It seems that the metallic posts' external configuration does not influence the stress distribution. **Conclusion:** Fiber posts show more homogeneous stress distribution than metallic posts. The post material seems to be more relevant for the stress distribution in endodontically treated teeth than the posts' external configuration. **PDF**

Soares, CJ, Soares, PV, de Freitas Santos-Filho, PC, Castro, CG, Magalhaes, D, Versluis, A. **The influence of cavity design and glass fiber posts on biomechanical behavior of endodontically treated premolars.** *J Endod. 2008 Aug;34(8):*1015-9

The aim of this study was to evaluate the effect of cavity design and glass fiber posts on stress distributions and fracture resistance of endodontically treated premolars. Fifty extracted intact mandibular premolars were divided into 5 groups (n = 10): ST, sound teeth (control); MOD, mesio-occlusal-distal preparation + endodontic treatment (ET) + composite resin restoration (CR); MODP, mesio-occlusal-distal + ET + glass fiber post + CR; MOD2/3, mesio-occlusal-distal + two thirds occlusal-cervical cusp loss + ET + CR; and MODP2/3, mesio-occlusal-distal + two thirds cusp loss + ET + glass fiber post + CR. The specimens were loaded on a cusp slope until fracture. Fracture patterns were classified according to four failure types. Stress distributions were evaluated for each group in a two-dimensional finite element analysis. The fracture resistance of the MODP, MOD2/3, and MODP2/3 groups was significantly lower than the ST and MOD groups ($p < 0.05$). The loss of dental structure and the presence of fiber post restoration reduced fracture resistance and created higher stress concentrations in the tooth-restoration complex. However, when there was a large loss of dental structure (MODP2/3), the post reduced the incidence of catastrophic fracture types. **PDF**

Spazzin, A.O., Galafassi, D., de Meira-Júnior, A.D., Braz, R., Garbin, C.A. **Influence of post and resin cement on stress distribution of maxillary central incisors restored with direct resin composite.** *Oper Dent. 2009 Mar-Apr;34(2):223-9.*

The current study evaluated the influence of two endodontic post systems and the elastic modulus and film thickness of resin cement on stress distribution in a maxillary central incisor (MCI) restored with direct resin composite using **finite element analysis** (FEA). A three-dimensional model of an MCI with a coronary fracture and supporting structures was performed. A static chewing pressure of 2.16 N/mm2 was applied to two areas on the palatal surface of the composite restoration. Zirconia ceramic (ZC) and glass fiber (GF) posts were considered. The stress distribution was analyzed in the post, dentin and cement layer when ZC and GF posts were fixed to the root canals using resin cements of different elastic moduli (7.0 and 18.6 GPa) and different layer thicknesses (70 and 200 microm). The different post materials presented a significant influence on stress distribution with lesser stress concentration when using the GF post. The higher elastic modulus cement created higher stress levels within itself. The cement thicknesses did not present significant changes. **PDF**

Uddanwadiker, RV, Padole, PM, Arya, H. **Effect of variation of root post in different layers of tooth: linear vs nonlinear finite element stress analysis.** *J Biosci Bioeng. 2007 Nov;104(5):363-70.*

The objective of this study was to obtain an accurate stress distribution pattern on different domains of a post- and core-treated tooth, taking into account the nonlinear properties of the periodontal ligament (PDL). Linear stress and deformation analysis was carried out using four posts, different in constitution and shape. Accurate three-dimensional models of a restored tooth with different layers were prepared using CAD modeling software. The study was carried out using a cast metal post and core assembly, a glass fiber, a carbon fiber, and a titanium post with a composite resin core. For each restoration, parallel, tapered and threaded posts were modeled. However, PDL exhibits nonlinear properties ensuring a uniform stress distribution in the tooth structure. Hence, accurate results could be expected by simulating the model for the nonlinear properties of PDL. Owing to computational difficulties, a simplified model was prepared in the ANSYS environment and nonlinear stress analysis was carried out. The results indicate that for optimum strength, rigidity and flexibility, tapered fiber posts with a composite resin core cemented to the root are desirable. Under similar loading conditions, in the case of nonlinear analysis, the stresses decreased by approximately 25% and the deformation increased by approximately 50% as compared with those in case of linear static analysis for an endodontically treated maxillary central incisor. Thus, stress distribution within the restored tooth and surrounding tissues can be better anticipated by a dentist. From the results of this study, the dimensions of a post could be modified, to further reduce stress in the oral cavity and thereby reduce the risk of root and post fractures.

Zhang, N, Feng, CZ, Zhao, SL, Fa, YH, Cai, XW. **Three-dimensional finite element analysis of effect of root canal taper and post on tooth stress distribution.** *Zhonghua Kou Qiang Yi Xue Za Zhi. 2011 Mar;46(3):153-6.*

Objective: To evaluate the effect of root canal taper and post on tooth stress distribution. **Methods:** Three-dimensional finite element models of human mandibular first molar with root canals prepared with 35# K file, ProTaper and Profile were established. The tooth were restored with fiber-resin, stainless steel and silver amalgam posts respectively. A vertical load on tooth occlusal

surface was simulated. Marc software was used to analyze and calculate the stress distributions in the tooth restored with three kinds of different root canal posts, especially the in the cervical part and root. **Results:** Different tapered root canals had no obvious influence on stress distribution in all three different posts. Stress distribution of stainless steel post located at the cervical and middle part of distal root, the highest Von-Mises stress was about 45 MPa. Stress distribution of silver amalgam post located at the orifice of root canal and pulp fundus, the highest Von-Mises stress was about 16 MPa. Stress distribution of fiber-resin post had no obvious stress concentration. **Conclusions:** Fiber-resin post is the most ideal root canal post. Stainless steel post causes remarkable stress concentration in the root, which may raise the possibility of root fracture**.**

D. Microleakage

Bae, S. , Kim, E-J, Chang, H-S. **Microleakage and fracture aspects of posts related with repeated loading**, *J Dent Res. 85 (Special Issue B) Abstract #1516, 2006 (www.dentalresearch.org)*

Objectives: The aim of this study was to compare the dye penetration under repeated loading using Cyclic Loading Machine, which stimulated masticatory system, and to evaluate the fracture aspects of different post systems. **Methods:** 25 single rooted incisors were divided into 5 groups; Cast posts, Para post, FRC Postec, CosmoPost, and endodontically treated teeth. Each post was cemented with Duo-Link (Bisco, U.S.A.), and core build-up was done using Light-Core (Bisco,U.S.A). Nittoflon Tape (Nitto Co. Japan) was used to simulate the periodontal ligaments. The load of 9.8N at 1 Hz for 50,000 cycles was applied to the angle of 45 degrees to the long axis of the tooth in 0.5% Fuchsine Basic solution on the Cyclic Loading Machine. After the fracture aspects were observed, the ratio of dyed surface area to the total root surface area was evaluated by Image Analyzer(Image Pro 4.0, U.S.A.) and statistically analyzed with Kruskal-Wallis Test and Duncan's Multiple Range Test at P=0.05. **Results:** The cast post showed the largest microleakage, while those of FRC Postec, Para post, CosmoPost were significantly lower($P<0.05$). The fracture lines of FRC Postec and CosmoPost were limited to the upper 1/3 of the root, while those of cast post and Para post were extended to middle 1/3 of the root. **Conclusions:** In view point of microleakage, FRC Postec, CosmoPost, and Para post showed less value. However, considering the fracture aspects together, the results indicate that FRC Postec and CosmoPost were meaningful clinically.

*Dasch, W., El-aryan, M., Roggendorf, MJ., Ebert, JA. Petschelt, Frankenberger, R. **Leakage of different luting cements for quartz-fiber post cementation**., *J Dent Res.Vol 87 (Spec Iss A) Abstract #3141, 2008 (www.dentalresearch.org)*

Objectives: Assessment of coronal leakage after quartz-fiber post cementation using adhesive and non-adhesive luting cements. **Methods:** Fourty root canals were prepared to apical size .02/#70 with K-reamers (Dentsply-Maillefer, Ballaigues/Switzerland). Root canals were obturated with AH-Plus sealer (DeTrey-Dentsply, Konstanz/Germany) and gutta-percha (Coltene-Whaledent, Langenau/Germany) and stored for 1 week under moist conditions at 37°C. Post preparation was performed with DT Post burs #3 (VDW-Dentsply, Munich/Germany). Teeth were randomly assigned to 5 groups (grp1-5, n=8) and DT White Posts (VDW-Dentsply) were luted with adhesive resp. non-adhesive cement: grp1: Harvard Cement (Richter & Hoffmann, Berlin/Germany); grp2: Ketac-Cem Aplicap (3M Espe, Seefeld/Germany); grp3: RelyX Unicem (3M Espe); grp4: Panavia-F 2.0/ED-Primer II (Kuraray-Dental, Kurashiki/Japan); grp5: Variolink II/Excite DSC (Ivoclar Vivadent, Schaan/Liechtenstein). Teeth were stored for 1 week under moist condition (100% rel. humidity) at 37°C. Leakage analysis was performed by a dye penetration test (5% aqueous methylene-blue solution/3min centrifugation time at 30g). Serial cross sections were investigated for dye penetration by means of a stereo microscope (magnification: x40). **Results:** The following mean leakage values were found (in mm+S.D.): grp1: 8.3+2.2; grp2: 6.9+2.6; grp3: 3.4+1.9; grp4: 5.6+3.2; grp5: 6.1+2.9. Kolmogorov-Smirnov test displayed normal distribution ($p>0.05$) for each group. Significant differences were detected between groups (ANOVA; $p<0.05$). RelyX Unicem and Panavia-F 2.0 revealed significantly less leakage compared to the other cements tested (t-test; $p<0.05$). **Conclusion:** Within the limits of this study, two adhesive cements revealed better results for cementation of quartz fiber posts showing less leakage in comparison to other cement systems tested.

Jung, SH, Min, KS, Chang, HS, Park, SD, Kwon, SN, Bae, JM. **Microleakage and fracture patterns of teeth restored with different posts under dynamic loading.** *J Prosthet Dent. 2007 Oct;98(4):270-6.*

Statement of problem: Many studies concerned with the microleakage of endodontically treated teeth restored with posts and cores and subjected to loading can be found in the literature. However, no studies have investigated microleakage under dynamic loading with simultaneous dye penetration, which is more relevant to clinical situations. **Purpose:** The purpose of this study was to compare microleakage and to classify fracture patterns of endodontically treated teeth restored with various post systems under dynamic loading. **Methods:** The crown portions of 40 human mandibular incisors were sectioned at the cementoenamel junction, and the teeth were endodontically treated. Teeth were divided into 4 groups (n=10): teeth restored with a cast post and core, prefabricated metal post (ParaPost), fiber-reinforced composite resin post (FRC Postec), and ceramic post (Cosmopost). After preparing the post space, each post was cemented with dual-polymerized resin cement (Duo-Link). With the exception of the cast post-and-core group, the cores were formed directly using a light-polymerized composite resin (Light-Core). An intermittent load of 98 N at 1 Hz was applied for 50,000 cycles at an angle of 135 degrees to the long axis of the restored teeth, which were immersed in

a 0.5% basic fuchsin solution. The ratio of the dyed surface area to the total area of the sectioned root surface was determined using an image analysis program. The data were analyzed by a 1-way ANOVA and Duncan's multiple range test (alpha =.05). The fracture patterns of the teeth were classified according to their fracture propagation lines. **Results:** The cast post group showed a significantly higher level of microleakage compared to the other groups (P=.001). Regarding the failure mode, the FRC Postec and Cosmopost groups showed fracture patterns that would favor retreatment. The number of cycles of repeated loading was not significantly different among the groups (P=.161). **Conclusions:** Both FRC Postec and Cosmopost groups showed less microleakage under dynamic loading and fracture patterns favoring a retreatment of fractured specimens.

Kazemi, R. B., Reid, L.C., Meiers, J. C**., A new test system for measuring concurrently fatigue and microleakage**, *J Dent Res. 81 (Spec. Iss. A) Abstract # 3130; 2002 (www.dentalresearch.org)*

Objectives: The purpose of this study was to develop and evaluate a non-destructive test system that could test concurrently fatigue and microleakage. **Methods:** A new multi-purpose computer-operated impact machine was designed and used in combination with a modified fluid filtration apparatus to evaluate concurrently both core integrity and post microleakage in the same sample. Crowns of single rooted teeth were removed and the roots were randomly assigned to five groups (n=10) and restored with the following post systems: one metallic group-Titanium ParaPost (TP) cemented with zinc phosphate, and four non-metallic groups-CosmoPost (CO), C-Post /Composipost (CP), Esthetic C-Post (EC), and FibreKor Posts (FK). All non-metallic posts were cemented with resin cement. Tetric Ceram was used for composite core for all groups. Samples were imbedded in an acrylic resin mold, connected to the filtration system and the baseline/control microleakage was measured. Samples were then placed in a positioning jig in the fatigue testing machine and subjected to 100,000 impacts at 45 degrees to the long axis of the root with a force of 55N at a frequency of 3HZ. After 60,000 impacts, the samples were subjected to 1,000 thermocycles (60KT) between 5^0C and 55^0C. Microleakage of the post systems was measured at 30K, 60K, 60KT and 100K cycles. **Results:** All samples showed no detectable displacement of any core. Mean +/-SD microleakage in microliters significantly increased in all groups as samples were subjected to increased impacts and thermocycling. The metallic group (TP) showed a statistically significant increase in microleakage ($p<0.05$) when compared to the non-metallic groups (CO, CP, EC and FK) at the conclusion of the study. **Conclusions:** The test design was successful in performing both fatigue loadings and microleakage measurements in the same sample using core integrity and prefabricated post microleakage as test parameters.

Medić V, Obradović-Djuricić K, Dodić S, Petrović R. **In vitro evaluation of microleakage of various types of dental cements.** *Srp Arh Celok Lek. 2010 Mar-Apr;138(3-4):143-9*

Introduction: Micro-leakage is defined as the clinically undetectable seepage of oral fluids containing bacteria and debris between cement layer and tooth restoration. **Objective:** This in vitro study investigated the effect of different dental cements (zinc-phosphate, polycarboxylate, glass-ionomer and resin cement) on micro-leakage in different ceramic crown systems (metal ceramic crown, metal ceramic crown with a porcelain margin, Empress 2 and in Ceram all-ceramic crowns) fixed on extracted human teeth. **Methods:** One hundred and sixty intact human premolars were randomized to four groups of forty teeth each, according to the different ceramic crown systems. They were prepared in a standardized manner for metal-ceramic and all-ceramic crowns. Crowns were made following a standard laboratory technique, and each group of crowns were divided into four groups according to the different cement agents and cemented on their respective abutments. The specimens were subjected to thermocycling, placed in methylene blue solutions, embedded in resin blocks and vertically cut in the bucco-lingual and mesio-distal direction. The microleakage in the area of tooth-cement interface was defined as linear penetration of methylene blue and was determined with a microscope to assign microleakage scores using a five-point scale. **Results:** A significant association was found between a cement type and degree of microleakage ($p = 0.001$). No statistically significant differences were found among the different ceramic crown systems luted with the same dental cement. The smallest degree of microleakage was observed in specimens luted with resin cement ($X = 1.73$), followed by glass-ionomer cement ($X=2.45$) and polycarboxylate cement ($X = 3.20$). The greatest degree of microleakage was detected in the crowns fixed with zincphosphate cement ($X = 3.33$). **Conclusion:** The investigated dental cements revealed different sealing abilities. The use of resin cement resulted in the percentage of 0 microleakage scores. Due to this feature, the resin cement is to be recommended in everyday clinical practice.

Reid, LC, Kazemi, RB, Meiers, JC. **Effect of fatigue testing on core integrity and post microleakage of teeth restored with different post systems.** *J Endod. 2003 Feb;29(2):125-31.*

The purpose of this study was to evaluate a new nondestructive test system, which could test concurrently fatigue and microleakage. Fifty, single-rooted teeth were restored with one of the following posts systems and a composite core: titanium ParaPost cemented with zinc phosphate cement; CosmoPost; C-Post; Esthetic C-Post; and FibreKor post, all cemented with resin cement. Samples were embedded and placed in a positioning jig. They were impacted at 45 degrees to the long axis of the tooth with a force of 55 N at a frequency of 3 Hz for a total of 100,000 impacts. After 60,000 impacts, samples were thermocycled. Core integrity and post microleakage were evaluated periodically throughout the 100,000 impacts. Samples showed no detectable displacement of any of the cores, but the metallic group showed a statistically significant increase in microleakage ($p < 0.05$) at the conclusion of the study compared with the nonmetallic groups. **PDF**

Sarı, T, Özyesil, AG. **Microleakage of teeth restored with different adhesive dowel systems: an in vitro study.** *J Prosthodont. 2014 Jan;23(1):45-9. doi: 10.1111/jopr.12054. Epub 2013 May 31.*

Purpose: Commercial fiber-reinforced dowel systems are marketed as having better adhesion and sealing ability than conventional metallic dowel systems. The aim of this in vitro study was to evaluate the micro-leakage of teeth restored with nine dowel systems.
Methods: Ninety mandibular second premolar teeth were de-coronated, and nine homogenous groups were composed of ten teeth each. Root canal and dowel space preparations were made, and eight fiber-reinforced composite dowel systems and one stainless steel dowel system were used to fabricate dowel restorations. Micro-leakage measurements of the restored teeth were made with a modified fluid filtration method, and data were collected. One sample Kolmogorov-Smirnov, one-way ANOVA, and Tukey-HSD tests were performed on the relative micro-leakage data of the groups. **Results:** Micro-leakage values were reported relative to those for teeth with unfilled canals. The highest and lowest relative micro-leakage values were recorded for the metallic Parapost (7.06 × 10(-4) %) and fiber-reinforced Everstick (3.55 × 10(-4) %) groups, respectively. Significant differences in relative micro-leakage between the fiber-reinforced dowels and stainless steel dowels were observed. Significant differences among the fiber-reinforced dowel groups were observed as well. **Conclusions:** The sealing ability of all fiber-reinforced composite dowels is not better than that of stainless steel dowels, and there are significant differences among different fiber-reinforced dowel systems as well. Differences among commercial dowel systems must be taken into consideration when making a selection.

Viţalariu A, Comăneci R, Tatarciuc M .**Analysis on the stress induced by non metallic posts in dental and periodontal support by using the finite element method** *[Article in Romanian] Rev Med Chir Soc Med Nat Iasi. 2006 Jul-Sep;110(3):705-10*

Aim: The determination of the influence of non-metallic posts on the stress distribution to the supporting tissues. **Methods:** Two 3D models were created: one intact maxillary incisor and one reconstructed with post (ceramic, carbon fiber and glass fiber). The compressive load (30daN) was applied to an angle of 45 degrees on the palatal surface of the crown. The Algor software computed the stress for each model comparing the maximum registered intensity, localization and concentration into the dento-periodontal complex. **Results:** The fiber reinforced posts induced lower stress peak inside the root, the von Mises stress in the teeth reconstructed with carbon and glass fiber post being similar to that recorded in a tooth without post. The ceramic post produced the greatest stress concentration in the middle third of the root, this behavior supporting the potential risk of the vertical root fractures registered "in vivo". **Conclusions:** The fiber reinforced posts are more suitable for the clinical longevity of the tooth, representing the best choice to reconstruct an endodontically treated tooth.

E. Failure mode

Bae, J-M., Park, J-S, Kim, Y-J, et al **Effect of component and shape of posts on fracture aspects.** *J Dent Res. Vol 83 (Spec. Iss. A) Abstract #3135, 2004 (www.dentalresearch.org)*

Objectives: This study was to compare the fracture resistance and failure mode of natural teeth with endodontically treated teeth, with and without post systems that have different shapes and components. **Methods:** Total 45 human mandibular incisors were divided into 9 groups; natural teeth (A), root canal treated teeth without post (B), and teeth with their crowns removed and restored with seven kinds of post systems. Each post was cemented with dual-cured resin cement, Duo-Link (Bisco) and core build-up was done with light-cured composite, Light-Core (Bisco), except cast posts. Each specimen was embedded in acrylic resin with periodontal ligament simulation and shear load was applied using universal testing machine (Z020, Zwick) at a crosshead speed of 5 mm/min. After test, the fracture aspects were evaluated by naked eye and SEM. **Results:** The data of fracture resistance were analyzed by Kruskal-Wallis test and Duncan's multiple range test at P=0.01 (unit: N). The highest fracture resistance was recorded for Cast post and Para post (P<0.01). In failure mode, C-Post and FRC Postec showed favorable aspects with few cracks around apical third. **Conclusions:** The carbon and glass fiber posts with tapered shape resulted in good failure mode, in spite of their lower strength than metal post, meaning the possibility of re-treatment.

Barjau-Escribano, A., Sancho-Bru, JL, Forner-Navarro, L et al, **Influence of prefabricated post material on restored teeth: Fracture resistance and stress distribution.** *Operative Dentistry, 2006 31-1, 47-54.*

Aims: This work studied how prefabricated intra-radicular post material affects the mechanical performance of restored teeth. The effect of using two different materials (glass fiber and stainless steel) with significantly different elastic moduli was studied. **Methods:** A combined theoretical and experimental method was used; first, an experimental fracture strength test was performed on 6 extracted human maxillary central incisors. The teeth were de-coronated, treated endodontically and restored-30 with glass fiber posts (Parapost Fiber White; Coltene/Whaledent, Cuyahoga Falls, OH, USA) and 30 with stainless steel posts (ParaPost; Coltene/Whaledent, Cuyahoga Falls, OH, USA). The data were recorded and the results compared using an ANOVA test. Then, the Finite Element technique was used to develop a model of the restored tooth. For both post systems, the model allowed for the study of the stress distribution patterns on the restored tooth under external loads. **Results:** For teeth restored with stainless steel posts, a significantly lower failure load was found, as compared with those teeth restored with glass fiber posts (520N versus 803N). The estimated distributions confirmed a worse mechanical performance on teeth restored using stainless steel posts, with a

high stress concentration due to the significant difference between the elastic moduli of the steel and the surrounding materials (207GPa versus 18.6GPa). **Conclusion:** Within the limitations of this study, post systems where the elastic modulus of the post is similar to that of the dentin and core, have a better biomechanical performance. Moreover, the failure mode for these fiber post systems will allow for further repair. **PDF**

Bruhnke, M Sterzenbach, G., Rosentritt, M., von Stein-Lausnitz, , M., Beuer, F., Naumann, M. **Do endodontically treated incisors benefit from post-based resin composite restorations?** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #1615, 2017(www.dentalresearch.org)*

Objectives: The aim of this in vitro study was to evaluate the impact of post placement on the maximum load capability of endodontically treated maxillary incisors with different extent of remaining coronal tooth structure. **Methods**: 96 extracted human maxillary incisors were endodontically treated and randomly distributed into 4 groups (n=24) according to cavity extension. In each group half of the specimens received an adhesively luted fiber post. The coronal substance loss increased from group A to D: access cavity only (A), access and uni-proximal cavity (U), access cavity and bi-proximal cavity (B). Teeth in group D were decoronated 2 mm above the cemento-enamel junction. All teeth were restored directly with a resin composite filling. Prior to linear loading (v=1mm/min) specimens were exposed to thermo-mechanical loading (TCML: 1,2 Mio cycles, 1- 50 N; 6000 thermal cycles from 5 / 55 °C/ 2 min each). Statistical analysis was performed using Log Rank test after TCML, Kruskal-Wallis- and Mann-Whitney-U-Test for comparison of load capability between groups. All tests were two-sided (p=0.05). **Results**: Significantly more early failures occurred during TCML in group D for specimens without FRC-posts (p=0.001). The median maximum load capability differed significantly among groups (p= 0.003). Pair-wise analysis between experimental groups revealed lower Fmax values only for teeth in group D without fiber posts ($p < 0.035$). The predominant failure mode was root fracture in groups A to C. In group D mainly coronal fractures were observed. **Conclusions**: Endodontically treated teeth with increasing coronal substance loss up to biproximal cavities can be successfully restored directly with composite resin only. An additional post-placement has no effect on load capability of teeth with access cavity and class-III restorations. However, teeth with no remaining cavity wall benefit from post-placement.

Castro, CG, Santana, FR, Roscoe, MG, Simamoto, Jr, PC Santos-Filho, Soares, CJ. **Fracture resistance and mode of failure of various types of root filled teeth.** *doi: 10.11.1365-2591. 2012. 02041.X.*

Purpose: to investigate ex-vivo the influence of the post system on fracture resistance and failure mode of root filled incisor, canine, pre-molar and molar teeth. Methods: 80 human teeth were divided into 8 groups (n = 10) resulting from the interaction between the 2 study factors: post system (glass fiber post; cast Ni-Cr alloy post and core) and type of tooth (maxillary incisors, maxillary canines, maxillary premolars and mandibular premolars). All roots were prepared with a 2 mm ferrule and restored with a metal crown. Fracture resistance (N) was assessed in a mechanical testing device, in the data were analyzed by a 2-wayANOVA (4x2) followed byTukey's Test (a=0.05). The failure mode was evaluated using an optical stereomicroscope and classified according to the location of the failure. Failure mode data were analyzed by 2-factor ANOVA and student-NewmanK-euls (SNK) tests. Correlation between fracture resistance and failure mode was analyzed by linear regression. Results: glass fiber and cast posting course had similar fracture resistance, regardless of the type of tooth. Canines and molars had significantly higher fracture resistance ($P<0.001$) then premolars. Incisors had significantly lower fracture resistance($P< 0.001$) than premolars. The fracture mode for incisors, premolars and molars was more amenable to restoration when the teeth were restored with glass fiber posts. Fracture resistance had no correlation with fracture mode, regardless of the post system and type of tooth analyzed. **Conclusion**: post system had no significant effect on the fracture resistance, regardless of the type of tooth. The motor fracture was more restorable with glass fiber posts. **PDF**

Cormier, C., Burns, D., Moon, P., **In vitro comparison of the fracture resistance and failure mode of fiber, ceramic, and conventional post systems at various stages of restoration**. *J Prosthodont 2001; 10:26-36*

Purpose: This in vitro study evaluated 6 post systems over 4 simulated clinical stages of tooth restoration to (1) determine quantitatively the fracture resistance strength at each stage when a static loading force is applied to cause fracture (2) determine the failure mode for each post system at each simulated stage and (3) determne the feasibility of removing failed post systems. **Methods:** Ten post systems made with various materials and designs were tested at the following 4 stages of simulated clinical treatment: Stage 1: post only, loaded using a 3-point loading model to failure to determine transverse strengths and failure modes for each post system, Stage 2: Posts alone bonded into teeth, Stage 3: posts bonded into teeth with core build-up, Stage 4: post and core build-ups with full veneer restorations.For stages 2 through 4, the coronal portion of 60 mandibular premolars were amputated at the cemento-enamel junction (CEJ), the canals were treated enddodontically, and the specimens were mounted in acrylic blocks. A testing force was applied to the posts at 90 degrees to the long axis of the tooth, 4mm from the CEJ.The O'Brien test for constant variance was performed over the treatment groups. For non constant variance, the Welch analysis of variance was used to test for equalities of treatment means. The Tukey Kramer procedure determined which treatment procedures differed. **Results:** The failure thresholds for each post system were significantly different at each stage of testing, but the order of test results remained generally consistent from one stage to the next. ParaPosts (Coltene Whaledent) and and core build-up resulted in higher failyre thresholds through all 4 stages of testing. This post system also displayed a high number of nonfavorable tooth fractures. FibreKor Posts (Jeneric-Pentron) resulted in significantly lower failure threshold values, in stages 2 through 4. This post system

with the other systems. C-Post / Composipost (Bisco Dental / RTD, St Egreve, France) , Cosmopost (Ivoclar/Vivadent) and Aestheti-Post (Bisco Dental / RTD, St Egreve, France) grouped in descending order through stages 2 to 4. These systems displayed intermediate fracture resistance strengths, as well as a moderate number of non-favorable tooth fractures. Cosmopost displayed a significant number of brittle post fractures with fragments left in the root canal at all stages. The fracture resitance of the cast metal posts varied from stage to stage. No teeth fractured at stage 2. At stage 3, 9 of 10 teeth fractured non-favorably , and all teeth fractured nonfavorably in stage 4. **Conclusions:** The fiber posts evaluated provided an advantage over a conventional post that showed a higher number of irretrievable posts and unrestorable root fractures. At the stage of final restoration insertion, there was no difference in force to failure for all but the FibreKor material, which continued to be weaker than all the other tested materials. The fiber posts were readily retrievable after failure, whereas the remaining post systems tested were non-retreivable. **PDF**

de Queiroz, VS, Pizi, EC, Soares, CJ, Macedo, VC, Martins, LR. **Fracture resistance of composite resin cores with or without prefabricated posts over different substrates**. *Gen Dent. 2011 Sep;59(5):e214-8.*

The fracture resistance of endodontically treated teeth has been an obstacle to the durability of the remaining teeth and restorations. The aim of this study was to evaluate the fracture resistance of endodontically treated bovine and human teeth that were restored with either prefabricated metal posts, glass fiber posts, or composite resin cores. Statistical analysis revealed significant difference between different substrates, but there was no statistically significant difference between different types of intraradicular posts or in the interaction between substrate and post types. **Conclusions:** The intraradicular posts do not increase the fracture resistance of endodontically treated teeth. The metal posts presented more unfavorable fracture modes when compared to glass fiber posts and composite resin cores.

Fokkinga, W**.** A., Creugers, N. H., Kreulen, C. M. **In vitro failure mode of fiber-reinforced post-core systems: A systematic review**. *J Dent Res. Vol. 82 IADR Abstract #2563, 2003 (www.dentalresearch.org)*

Objectives: To compare in vitro failure modes of fiber reinforced post systems with prefab metal and cast post systems. **Methods:** The literature was searched using MEDLINE, with the year limits 1984-2002/6 for dental articles written in English, German or Dutch. Key words: (post or core or build-up or dowel) and (teeth or tooth) not (implant or orthodontic or periodontal or primary teeth). The following steps were conducted: 1) Inclusion of abstracts describing post-core techniques to reconstruct endodontically treated teeth and their mechanical characteristics (strength, fracture, failure, resistance, survival, retention, leakage, seal). Descriptive studies or reviews were excluded. 2) Inclusion if in vitro studies on fracture resistance of single rooted human teeth restored with prefab fiber posts and composite cores. 3) Failure mode categorization. Favorable failures were defined as repairable failures including adhesive failures, and fractures above bone simulation. Unfavorable were non-repairable, vertical root fractures. Steps 2) and 3) were conducted using the Aim, Materials and Methods and Results of the articles. All assessments were done by 2 operators. Consensus was reached in case of disagreement. Kappa's were used for observer agreement. Percentages of favorable failures of the post systems were compared using Wilcoxon Signed Rank Test. **Results:** MEDLINE identified 1237 articles. Results of each step: inclusion of 203 articles (Kappa=0.86) of which 21 dealt with fibers, 2) inclusion of 8 articles (Kappa=0.62) of which 6 dealt with failure mode of carbon fibers, 3) failure mode categorization per system (Kappa=0.99). Favorable failures occurred significantly more with the carbon fiber reinforced posts than with the prefab metal (n=11, p=0.05, z=1.96) and respectively, the cast post groups (n=8, p=0.02, z=2.39). **Conclusions:** These results suggest a more favorable failure mode of the Carbon fiber post systems compared with prefab metal and cast post systems. Comparative studies of the different post systems are scarce

Fuss, Z., Lustig, J., Katz, A., Tamse, A. **An evaluation of endodontically treated vertical root fractured teeth: impact of operative procedures**. *J Endod Vol. 27, No.1, 2001.*

Vertical root fractures of endodontically treated teeth are a frustrating complication that leads to extraction. The aim of the current survey was to evaluate the role of operative procedures in the etiology of this complication. A total of 154 endodontically treated vertical root fractured teeth were cleaned and washed after extraction and maintained in individual vials. Periapical radiographs before extraction, clinical findings and previous operative procedures were recorded. A post was observed in 95 teeth (61.7%), with 66 of these ending at the coronal third of the root. Most were screw posts of the Dentatus type (n=64) and tapered cast post (n=14). A full crown was observed in 118 teeth, and 65 of these (55%) were extracted between 1-5 years after final restoration. In 24 crowned teeth extraction was conducted within 1 year after restoration and in 28 teeth after >5 years. It was concluded that post placement and root canal treatment are the major etiological factors for root fractures. Because signs and symptoms can appear years after the operative procedure in the root have been completed, coronal restorations would not interfere with the correct clinical diagnosis of vertical root fractures. Frequent recalls are recommended to diagnose vertical root fractures early, especially in susceptible teeth, such as premolars and mesial roots of mandibular molars. **PDF**

Gu , XH, Huang, JP, Wang, XX. **An experimental study on fracture resistance of metal-ceramic crowned incisors with different post-core systems**. *Zhonghua Kou Qiang Yi Xue Za Zhi. 2007 Mar;42(3):169-72 [Article in Chinese]*

Objectives: To evaluate fracture resistance of metal-ceramic crown restored incisors with different post-and-core systems. **Methods:**: Selected 40 intact maxillary central incisors were endodontically treated and then randomly assigned to four groups of 10

teeth each. Teeth in Group A were prepared to root canal with 10 mm in length, 1.6 mm in diameter and restored with fiber-reinforced posts (Snowpost, Carbotech) and composite cores. Same final preparation but root canal with 1.5 mm in diameter was achieved for teeth in the other three groups. Teeth in Group B were restored with prefabricated titanium alloy posts (ParaPost, Coltene-Whaledent) and composite cores and teeth in Group C were restored with cast nickel-chromium post-cores. The posts were luted with a composite resin luting system, and metal-ceramic crowns were restored and cemented with the same luting system for all of the teeth in Group A, B and C. The other 10 teeth were restored with cast nickel-chromium post-cores and metal-ceramic crowns as a control, which were cemented with glass-ionomer cement. All restored teeth were thermocycled for 5000 cycles (5 degrees C/55 degrees C) as a fatigue test. The tooth was loaded in a universal testing machine at an angle of 135 degrees to the long-axis at the incisal edge with a crosshead speed of 1.5 mm/min until fracture. Fracture loads (N) and modes (repairable or catastrophic) were recorded. One-way ANOVA and SNK test were used to determine the significance of the failure loads between groups. Chi-square test was conducted for evaluation of the fracture mode. **Results:** The fracture loads from Group A, B, C and control group were (534.4 +/- 145.7) N, (499.8 +/- 168.9) N, (412.6 +/- 99.3) N, (337.4 +/- 121.2) N, respectively. A significant difference was existed among four groups ($P < 0.05$). The fracture loads of Group A and Group B were significantly higher than control group ($P < 0.05$). The repairable mode of fracture observed from Group A to control group was 80%, 40%, 20% and 30%, Group A had a significantly higher number of repairable fractures than those of the other groups ($P < 0.05$). **Conclusions:** Within the limitations of this study, fiber-reinforced post has an excellent fracture resistance, and can be recommended as an alternative to cast post-cores, especially for incisor esthetic restoration

*Hegde, J., Ramakrishna, T., Bashetty K, Srirekha, Lekha, Champa. **An in vitro evaluation of fracture strength of endodontically treated teeth with simulated flared root canals restored with different post and core systems**. *J Conserv Dent. 2012 Jul;15(3):223-7.*

Purpose: The objective of this study is to evaluate the fracture strength and mode of failure of endodontically treated teeth with flared canals restored with two fiber reinforced systems (glass fiber and quartz fiber) and one base metal cast post and core system. **Methods:** Forty-five anterior teeth were de-coronated at cemento-enamel junction and were endodontically treated. Post space was prepared and randomly divided into three groups according to post system. Specimens were loaded at 45° in a universal testing machine at a cross head speed of 0.5 mm/min until failure. The mode of failure was classified as repairable or non-repairable. **Results:** Teeth restored with cast posts have fracture strength twice that of teeth restored with fiber posts. Fiber-reinforced posts failed at a certain compressive force but they were repairable unlike the non-repairable fracture seen with cast posts. **Conclusion:** The results of this study showed that, fracture strength and mode of failure in anterior teeth with flared canals varied according to the type of post used to support a crown. **PDF**

*Hou, QQ, Gao, YM, Lei Sun, L. **Influence of fiber posts on the fracture resistance of endodontically treated premolars with different dental defects**. *International Journal of Oral Science advance online publication, 2 August 2013; doi:10.1038/ijos.2013.52*

This study aimed to evaluate the influence of quartz fiber post placement on the fracture resistance of endodontically treated premolars with different dental defects under dynamic loading. Fifty extracted single-rooted mandibular premolars were randomized into five groups. Each group was prepared according to numbers of residual walls ranged from 0 to 4. Then each group was divided into two subgroups with one restored with quartz fiber posts and the other without posts. In no-post groups, gutta percha point 2 mm below cemento-enamel junction was removed. Composite resin was adapted to the well and used to shape the core directly. Each tooth was restored with a complete metal crown. Dynamic loading was carried out in a masticatory simulator with a nominal load of 50 N at 2 Hz for 300,000 loading cycles. Then a quasi-statically load was applied in a universal testing machine 306 to the long axis with a crosshead speed of 1 mm/min until fracture. Data were analyzed with one-way analysis of variance and pairwise comparison (P,0.05). No specimens failed during dynamic loading. The fracture resistance enhanced with the increase of numbers of coronal walls and the differences were significant (P,0.05). Placement of fiber posts had a significant effect when fewer than two walls remained (P,0.05), but it had no significant influence in groups with two, three or four walls (P.0.05). Fiber post did not change failure mode, and the fracture pattern was mainly favorable. More dentin walls need to be retained in clinic. When no less than two walls remained, a fiber post is not always necessary. **PDF**

Kaya, BM, Ergun, G. **The effect of post length and core material on root fracture with respect to different post materials**. *Acta Odontol Scand. 2012 Nov 20*

Objective: The aim of this study was to evaluate the effect of different core materials and post length on the fracture strength of different posts (CAD/CAM zirconia post (ZR post)) and an individually formed glass fiber reinforced composite post (FRC post). **Methods:.** One hundred maxillary central incisors received endodontic treatment and were divided into two groups according to the post length: (1) 10 mm in length and (2) 15 mm in length (n = 50/per group). Then the specimens were randomly assigned into five sub-groups (n = 10/per group) as follows: One-piece milled zirconia post and core (group Zr), zirconia post with resin core (Biscore, Bisco) (group Zr/R), zirconia post with resin composite core (Admira, Voco) (group Zr/RC), FRC post with resin core (group F/R) and FRC post with resin composite core (group F/RC). The posts were cemented with a self-adhesive luting agent according to the manufacturer's instructions by using endo tips and light-cured for 40 s using a halogen light curing unit. Metal crowns were made for each specimen, cemented and loaded to failure. Fracture loads (N) and modes of failure were recorded. The

data were analyzed using three-way analysis of variance (ANOVA) followed by Tukey's post-hoc test ($p < 0.001$). **Results:** Fracture strength of roots was significantly affected by the type of post material ($p < 0.05$) and post length ($p < 0.05$), but not by the type of core materials used ($p = 0.078$). **Conclusion.** Longer zirconia posts with zirconia- or resin-based cores can be recommended as an alternative to FRC posts with resin-based cores. The fracture patterns observed in teeth restored with fiber posts were more favorable than teeth restored with zirconia posts. **Clinical significance**. A higher restoring success rate can be achieved by fiber posts rather than zirconia posts, since the failure mode for these posts would be restorable. Additionally, post length is a more critical factor in teeth restored with one-piece milled zirconia posts than in those restored with fiber posts.

Krug, KP, Otter SE, Knauber AW, Erdelt KJ, Nothdurft FP. **Influence of proximal contacts and FRC posts on the fracture behavior of premolars with class II composite restorations: an in-vitro study**. *Dent Mater J. 2013 Nov 30;32(6):952-8. Epub 2013 Nov 15.*

The purpose of this study was to evaluate the influence of the number of proximal contacts and fiber-reinforced composite (FRC) post insertion on the fracture behavior of endodontically treated premolars with class II (MOD) cavities and direct composite restorations. Forty-eight single-rooted human premolars were endodontically treated and prepared with standardized MOD (mesio-occluso-distal) cavities. One-half of the teeth additionally received FRC-posts (DT Light SL; RTD/VDW) luted with Panavia F resin cement. All of the specimens were restored with direct composite restorations, and the teeth were embedded in proximal contact with either zero, one or two adjacent tooth-replicas. Eight sound premolars served as control. After thermo-mechanical aging, the samples were loaded until fracture at an angle of 30°. The sound teeth showed the highest mean fracture load. Teeth with one or two proximal contacts and FRC-posts showed only statistically insignificantly lower values. All of the other groups had significantly lower values.

Lang, H., Raab, W., **Interferometric assessment of teeth restored with different post systems.** *J Dent Res, Vol 84 (Spec. Iss. A) Abstract #0666, 2005 (www.dentalresearch.org)*

Objectives: This study evaluated the deformation of endodontically treated teeth with 3 different post systems at 4 simulated clinical stages. **Methods:** Extracted human anterior maxillary teeth (n=30) were used and randomly assigned to 3 groups (i.e. post systems): fiber-reinforced epoxy resin posts –Group 1 (ER DentinPost), zirconium oxide ceramic posts –Group 2 (ER CeraPost) and titanium posts –Group 3 (ER Titan post) (all from Komet, Brasseler GmbH, Lemgo, Germany). A series of endodontic treatments was applied and after each single procedure the teeth were loaded (3.75N) and the deformation was assessed using Speckle pattern interferometry. The following treatments were applied: a) no treatment (control), b) access preparation and initial root canal instrumentation (Kerr files ISO 40), c) post preparation (Size 110) and d) cementation of the posts (gr. 1+2: resin bonded / Gr. 3: zinc phosphate cement). **Results:** Access preparation (with root canal instrumentation) and post preparation significantly increased the deformation under loading ($p<0.05$ - one-way ANOVA and post-hoc Scheffé test). All posts reduced the deformation of the teeth but the levels were significantly different: titanium posts - 0.38±0.02µm > zirconium oxide ceramic posts - 0.45±0.02µm > fiber-reinforced epoxy resin posts - 0.53±0.03µm ($p<0.05$). **Conclusion:** It can be concluded that a) the increase of stability corresponds to the mechanical properties of the post materials and that b) the fiber-reinforced epoxy resin posts can almost preserve the deformation pattern of teeth without a post. This might be favorable in view of studies showing a high incidence of unrestorable root fractures in case of post materials with mechanical properties significantly different from the properties of root dentine.

*Latta, ,M. A., Barkmeier,W. W. , Kimmes,,N. S. , O'Meara, J. D. **Failure resistance of post-core assemblies**. *J Dent Res 85, (Special Issue A) #0377, 2006 (www.dentalresearch.org)*

Resistance to lateral loading is critical for clinical success of the post/core assembly. **Objective:** The purpose of this in-vitro study was to evaluate the load resistance and failure mechanism of glass fiber and metal retained core build-ups. **Methods:** Following the removal of the clinical crown, gutta percha was used to restore canals prepared to size 40 in 60 extracted human anterior teeth. After storage in water for 1 week at 37^0C, post preparations were made to a depth of 9mm and parallel ParaPost, FibreKleer and FibreKor posts and tapered FibreKleer and D.T. Light-Post were cemented using Bond-1 adhesive and Lute-It cement. Using a gelatin capsule matrix a core was fabricated using Build-It resin. A flat area was prepared on the core at a 45º angle to the lingual/occlusal aspect of the post/core/tooth assembly. The specimens were stored in water for 24 hours at 37^0C, thermocycled and loaded to failure at a crosshead speed of 1mm/min in an Instron testing machine. **Results:** Mean load at failure (in Newtons) and failure pattern for each group are presented. ANOVA and post hoc LSD tests revealed significant differences in load failure ($p<0.05$). Groups with a similar letter are statistically similar ($p>0.05$). **Conclusion:** Metal posts generated the highest resistance to failure of the post/core assembly but also the highest root fracture.

Le Bell-Rönnlöf AM, Lassila LV, Kangasniemi I, Vallittu PK. **Load-bearing capacity of human incisor restored with various fiber-reinforced composite posts.** *Dent Mater. 2011 Jun;27(6):e107-15. Epub 2011 Mar 27.*

Objectives: The aim of this study was to evaluate the load-bearing capacity and microstrain of incisors restored with posts of various kinds. Both prefabricated titanium posts and different fiber-reinforced composite posts were tested. **Methods:** The crowns of human incisors were cut and post preparation was carried out. The roots were divided into groups: (1) prefabricated serrated titanium posts, (2) prefabricated carbon fiber-reinforced composite posts, (3) individually formed glass fiber-reinforced

composite posts with the canal full of fibers, and (4) individually formed "split" glass fiber-reinforced composite posts. The posts were cemented and composite crowns were made. Intact human incisors were used as reference. All roots were embedded in acrylic resin cylinders and stored at room temperature in water. Static load was applied under a loading angle of 45° using a universal testing machine. On half of the specimens microstrain was measured with strain gages and an acoustic emission analysis was carried out. Failure mode assessment was also made. **Results:** The group with titanium posts showed highest number of unfavorable failures compared to the groups with fiber-reinforced composite posts. **Conclusions:** fiber-reinforced composite posts the failures may more often be favorable compared to titanium posts, which clinically means repairable failures. **PDF**

Li, Q., Xu, B., Wang, Y., Chen, X. **Effects of ferrule height and post dimension on post-restored teeth.** *J Dent Res.Vol 92 (Spec Iss A) Abstract #3195, 2013 (www.dentalresearch.org)*

Objectives: To explore the potential interaction effect of ferrule height and post dimension on the fracture resistance of post-restored teeth. **Methods:** Sixty endodontically treated incisors were randomly assigned into four groups (n=15), and decoronated at 0 mm, 1 mm, 2 mm, and 3 mm to the proximal cemento-enamel junction (CEJ). The roots were restored with fiber posts of various dimensions. All specimens were subjected to fracture failure tests, loaded with an incremental force at an angle of 135° to the long axis of the roots. Fracture failure strengths were recorded and analyzed using analysis of variance (ANOVA), followed by Tukey's post hoc comparisons (α=0.05). The fracture modes were investigated using fractographic analysis. **Results:** The interaction effect of ferrule height and post dimension was detected (P=0.006). Post dimension significantly influenced the fracture failure strengths of specimens with 0 mm and 1 mm ferrule. No significant difference was found between 2# and 3# posts in 2 mm group, or among all the dimensions of posts in 3 mm group. Debonding of the crown/dentin interface occurred in all specimens. And increasing of ferrule height decreased the probability of the debonding at the core/dentin interface. **Conclusions**: The effect of post dimension on fracture resistance decreases with the increasing of ferrule height. Increasing of ferrule height potentially postpones the processing of the ultimate fracture failure.

McLaren, J.D., McLaren, C.I., Yaman, P., Bin-Shuwaish, M.S., Dennison, J.D., McDonald, N.J. **The effect of post type and length on the fracture resistance of endodontically treated teeth.** *J Prosthet Dent. 2009 Mar;101(3):174-82.*

Statement of problem: Few studies have been conducted to determine a correlation between the flexural modulus of metal and fiber-reinforced posts and the fracture resistance and failure mode of teeth restored with posts. Questions remain as to whether a longer post length or a post with a higher flexural modulus will significantly improve the fracture resistance of a tooth restored with a prefabricated post and core. **Purpose:** The purpose of this study was to compare the fracture resistance and mode of failure of endodontically treated teeth restored with 3 different post systems, including 2 fiber-reinforced posts (Light-Post and Snowlight) and a stainless steel post (ParaPost XP). **Methods:** Seventy single-rooted premolars were sectioned at the cemento-enamel junction and then endodontically treated. Teeth were distributed into 7 groups. Three different prefabricated posts were cemented into a post space either 5 or 10 mm in depth, and composite resin (ParaPost ParaCore automix) cores were fabricated. A composite resin core group without a post served as a negative control. Specimens were loaded at 90 degrees to the longitudinal axis until ultimate failure occurred. An initial failure load and mode of failure were also recorded. Statistical analysis was performed for initial and ultimate failure loads of groups by using 2-way ANOVA (P=.05). **Results:** The groups with ParaPost XP posts demonstrated significantly higher initial and ultimate mean failure loads when compared with the fiber-reinforced post groups. The highest mean (SD) initial failure load was with the ParaPost XP group with a 10-mm post length (170.05 (60.08) N), and the lowest was with the Snowlight group with the 5-mm post length (62.85 (18.47) N). **Conclusions:** The stiffness and the load to initial fracture of the teeth restored with ParaPost XP posts were higher compared with the fiber-reinforced post groups. The stainless steel posts had an incidence of **25% root fractures,** while no root fractureas were observed with the fiber posts. Clinical Implications: The results of this study suggest that a stainless steel post may provide better support for a composite core than a fiber –reinforced post when a 90 degree load is applied. **PDF**

Mannocci, F., Ferrari, M., and Watson, T. F. **Intermittent loading of teeth restored using quartz fiber, carbon-quartz fiber, and zirconium dioxide ceramic root canal posts**. *Journal of Adhesive Dentistry. 1: 153-158, 1999.*

Purpose: The purpose of the investigation was to compare the performances of teeth restored with quartz-fiber, carbon-quartz fiber, and zirconium-dioxide posts covered with all-ceramic crowns when subjected to a cyclic loading tests performed in a wet environment. **Methods:** Forty single-rooted human lower premolars having similar dimensions were endodontically treated and mounted in acrylic resin blocks with a simulated periodontal ligament. The teeth were divided into three experimental groups and one control group. Post holes 8 mm long were prepared in the roots of the experimental groups in which quartz fiber (Aesthetti-Plus, RTD, St Egreve, France), carbon-quartz fiber (Aestheti-Post; RTD, St Egreve, France), and zirconium dioxide (Cerapost) posts were cemented. In the control group, no posts were used. The crown buildup was made with composite resin. The teeth were covered with all-ceramic crowns and intermittently loaded an at angle of 45 degrees to the long axis of the tooth at a frequency of two loads per second. **Results:** Only one failure (root fracture + post fracture), was observed in each of the fiber post groups, while in the zirconium dioxide post group, six failures were observed (one crown fracture and 5 root fracture + post fractures). The Kaplan-Meier analysis of the three experimental groups showed that the survival rate of zirconium dioxide posts was significantly lower than that of both types of fiber post. All the experimental groups showed a survival rate higher than that of the

control group. **Conclusions:** Fiber posts reduced to a minimum the risk of root fractures of teeth restored with composite cores and Empress crowns under the present experimental conditions (intermittent loading in a wet environment). **PDF**

Maroulakos G., Nagy, WW, Kontogiorgos, ED,. **Fracture resistance of compromised endodontically treated teeth restored with bonded post and cores: An in vitro study.** *J Prosthet Dent. 2015 Sep;114(3):390-7. doi: 10.1016/j.prosdent.2015.03.017. Epub 2015 Jun 2.*

Statement of problem: It is unclear which post and core system performs best when bonded to severely compromised endodontically treated teeth. **Purpose:** The purpose of this study was to investigate the fracture resistance and mode of failure of severely compromised teeth restored with 3 different adhesively bonded post and core systems. **Methods:** Thirty extracted endodontically treated maxillary anterior teeth were randomly divided into 3 groups, CPC, gold cast post and core; TPC, titanium prefabricated post/composite resin core; and FPC, quartz fiber reinforced post/composite resin core. All posts were adhesively cemented. All cores resembled a central incisor preparation with no remaining tooth structure above the finish line. Cast gold crowns were fabricated and cemented adhesively. The specimens were aged with thermocycling and cyclic loading. Two specimens per group were randomly selected for micro-computed tomographic imaging before and after aging. Failure was induced with a universal testing machine. The mode of failure was characterized by the interface separation. Data were analyzed with 1-way ANOVA (α=.05) followed by post hoc tests (Bonferroni). **Results:** A statistically significant difference was found among the 3 groups (P=.002). CPC was significantly different than TPC (P=.008) or FPC (P=.003). The primary mode of failure for CPC and TPC was root fracture, and for FPC post debonding. **Conclusions:** Severely compromised endodontically treated teeth restored with bonded gold cast post and cores showed significantly higher fracture resistance. **PDF**

*Muangamphan, P, Sattapan, B, Kukiattrakoon, B, Thammasitboon, K. **The effect of incomplete crown ferrules on fracture resistance and failure modes of endodontically treated maxillary incisors restored with quartz fiber post, composite core, and crowns.** *J Conserv Dent. 2015 May-Jun;18(3):187-91. doi: 10.4103/0972-0707.157239.*

Aim: To investigate the fracture resistance of restored endodontically treated teeth (RETT) with fiber posts, cores, and crowns with limited ferrules. **Methods:** Sixty maxillary anterior teeth were endodontically treated and de-coronated 2 mm above the cemento-enamel junction, and then divided into 6 groups of 10 teeth each; Group circumferential ferrule (2FR), Group ferrule in the labial, mesial, and palatal region (2FR-LaMPa), Group ferrule in the labial, and palatal region (2FR-LaPa), Group 2FR-Pa and 2FR-La respectively, and Group 0FR (no ferrule). All 60 prepared teeth were then restored with quartz fiber posts (DT Light-Post, RTD/ St Egreve, France), resin composite cores, and metal crowns. The specimens were subjected to load until failure occurred. Data were analyzed using one-way analysis of variance and Tukey's tests (α = 0.05). The mode of failure was determined under a stereoscope. **Results:** A statistical significant difference was found among groups 2FR-LaMPa, 2FR-Pa, 2FR-LaPa, and 2FR from the group 2FR-La, and from the group 0FR ($P < 0.01$). The predominant mode of failure was an oblique palatal to labial root fracture for the groups with remaining ferrules. **Conclusion:** For RETT that have incomplete crown ferrules, the location of the ferrules may affect their fracture resistance. **PDF**

*Ng, C., Dumbrigue, H., Al-Bayat, M., Griggs, J., Wakefield, C. **Influence of remaining coronal tooth structure location on the fracture resitance of restored endodontically treated anterior teeth.** *J Prosthet Dent 2006;95:290-6.*

Statement of problem: a restored endodontically treated tooth is less likely to fracture when there is axial tooth structure between the core base and preparation finish line. However an accurate prognosis requires knowing whether fracture resistance depends on a complete circumferential distribution of tooth structure or tooth structure in a specific location to the applied force. **Purpose:** This in vitro study investigated the fracture resistance of restored endodontically treated teeth when residual axial tooth structure was limited to one half of the circumference of the crown preparation. **Methods:** Fifty extracted maxillary anterior teeth were sectioned 18mm from ther apices, endodontically treated and divided into 5 groups of 10 teeth each. Four groups were prepared with full shoulder crown preparations having axial wall heights of 2mm around the preparation circumferences. In three of the groups with axial tooth structure, one half of the axial tooth structure was removed. Palatally, labially, or proximally and groups were identified according to the site of retained coronal tooth structure. For the fifth group, all axial tooth structure was removed to the level of the preparation shoulder. Thus, in one group the axial walls were circumferential, 360 degrees around the preparations (Complete group), in 3 groups the axial walls were continuous for 180 degrees (palatal, labial and proximal groups) and the last groups had no retained coronal tooth structure incisal to the finish line (Level Group). All 50 prepared teeth were then restored with quartz fiber posts (D.T. Light-Post; RTD, St Egreve, France/ Bisco Dental), composite cores (Bisco Dental) and metal crowns. A universal testing machine compressively loaded the tooth specimens at a crosshead speed of 0.5cm/minute at an angle of 135 desh line, the location degrees to the long axis of the teeth until failure occurred. A survival analysis was conducted using a log rank test followed by Holm-Sidak pairwise test (α=0.05) to detect significant differences in median failure load between groups. The mode of failure was determined by visual inspection of all specimens. **Results:** The median failure load (P<.001) was 607 N, 782N, 358N, 375N, and 172N for the Complete, Palatal, Labial, Proximal and Level groups, respectively. The predominant mode of failure was an oblique palatal to facial root fracture for the groups with remaining coronal tooth structure. In the Level group, post debonding was the predominant mode of failure. **Conclusion:** For restored endodontically treated teeth that

do not have complete circumferential tooth structure between the core and preparation finish line, the location of the remaining coronal tooth structure may affect their fracture resistance. **PDF**

Ni, CW, Chang, CH, Chen, TY, Chuang, SF. **A multi-parametric evaluation of post-restored teeth with simulated bone loss**. *J Mech Behav Biomed Mater. 2011 Apr;4(3):322-30. Epub 2010 Nov 3*

Endodontically-treated teeth are prone to fracture due to loss of tooth structure and altered mechanical behaviors. The stability and rigidity of post-restored teeth, particularly in cases involving periodontal destruction, has not been adequately investigated. This study examined the influence of post material on teeth with simulated bone reduction by a multiparametric evaluation. Sixty extracted premolars of similar sizes were endodontically treated then divided into six groups. Each group was restored with one of the combinations of three posts (a glass-fiber, a prefabricated titanium post, and a cast post) and two simulated bone conditions (2 or 6 mm below crown margins). After crown restorations, they were loaded with a 100 N force then the displacements were examined by the digital-image-correlation technique. Marginal integrity on the buccal and lingual crown margins was examined before and after the thermo-cycling. Finally, the teeth were loaded until failure to examine the strength and fracture patterns. The digital-image-correlation measurements revealed that tooth deformation was related to the support conditions, especially for the fiber post groups. The cast post groups showed less altered marginal integrity after thermo-mechanical loading than the fiber and titanium post groups did. In the fracture test, the fiber-post/reduced-support group exhibited inferior fracture strength. The reduced support significantly affected fracture strength and incidence of repairable root fracture. The marginal integrity was not correlated with tooth deformation, since the tooth flexed at the crest of the simulated bone. The root fracture resistance was determined mainly by post materials but was concurrently affected by the support conditions.

Pilo, R., Cardash, H., Levin, E., Assif, D. **Effect of core stiffness on the in vivo fracture of crowned, endodontically treated teeth**. *J Prosthet Dent 2002; 88:302-6.*

Statement of problem: Dentin and core materials that substitute for missing dentin are dissimilar materials. A core material with a lower elastic modulus may deform more under applied stress and therefore result in reduces stress concentration at the core/dentin junction. Purpose: This in vitro study examined the effect of core stiffness on the fracture resistance and failure characteristics of a crowned, endodontically treated tooth under simulated occlusal load. **Methods:** Forty extracted human mandibular premolars were divided equally into four groups and prepared for posts and cast crowns as follows: group 1 = cast post and core, cast crown; group 2 = preformed metal post composite core and cast crown,; group 3 = preformed metal post, amalgam core and cast crown; group 4 (control) = preformed metal post, no core and cast crown. All prepared teeth had 2mm of sound dentin on which the cemented crown rested. A continuous load (kg) was applied to the buccal cusp as a 30-degree angle to the long axis of the tooth at a crosshead speed of 2mm/min. until failure. Collected data were subjected to 1-way analysis of variance with the Welch modification to compare groups (<.05). **Results:** Failure loads for the 4 test groups were as follows: Group 1 98.1 +/- 34.6, Group 2 94.4 +/- 41.8, group 3 105.5 +/- 18.6, group 4 (control) 101.1 +/- 55.3kg. No significant difference in failure load values was found among the 4 groups. The primary mode of failure (80%) in all groups was an oblique radicular fracture, either apical to the post or at the post level. Horizontal fracture of the root and post was found in groups 1, 2 and 3 (30%). Loosening of the crown, post and core was found only in group 2 (20%). **Conclusion:** Within the limits of this study, core stiffness did not effect the failure resistance of teeth restored with posts and cores and complete coverage cast metal posts. The dominant pattern of failure was unrepairable root fracture. Only the composite core exhibited repairable fractures. **PDF**

Rosa, R, Hwas, A, Melo, D, Valandro, LF, Kaizer, O. **Fracture strength of endodontically treated teeth restored with different strategies after mechanical cycling.** *Gen Dent. 2012 Mar-Apr;60(2):e62-8.*

The aim of this study was to analyze the fracture strength of endodontically treated teeth with different coronal restoration strategies after mechanical cycling. Thirty bovine teeth were randomly allocated into three groups (n = 10): Group 1, cast metal post and core; Group 2, glass fiber post with a composite resin core; Group 3, glass fiber post with a glass prefabricated core. For post cementation, an etch and rinse multistep adhesive system and resin cement were used. The specimens were submitted to mechanical cycling (106 cycles, 90 N, 4 Hz, 37 ± 1 degree C) and immediately loaded in a universal testing machine. The statistical analysis (one-way ANOVA) did not indicate a significant difference among the tested groups (Group 1 = 593.9 ± 128.7 N; Group 2 = 554.4 ± 213.3 N; Group 3 = 427 ± 104.8 N; P = 0.06). With regard to fracture patterns, all Group 1 specimens demonstrated catastrophic failures, while the specimens in Groups 2 and 3 demonstrated core or core/post failure. Despite the similar fracture strength observed in the tested groups, teeth restored with composite resin or glass prefabricated cores demonstrated favorable failure patterns compared to the cast metal post and core group. This study demonstrates that a glass prefabricated core can be an acceptable alternative for the reconstruction of endodontically treated teeth.

Salameh, Z, Ounsi, HF, Aboushelib, MN, Sadig, W, Ferrari, M. **Fracture resistance and failure patterns of endodontically treated mandibular molars with and without glass fiber post in combination with a zirconia-ceramic crown.** *J Dent. 2008 Jul;36(7):513-9. Epub 2008 May 13*

Objective: The aim of this study was to investigate the influence of a fiber post on the fracture mechanics of zirconia crowns inserted over endodontically treated teeth with different extent of coronal damage. **Methods:** Endodontically treated human molars

with three types of coronal damage received fiber posts before cementation of zirconia-veneered crowns. Controls received composite resin cores without fiber posts. The specimens were loaded to failure and fractographically examined using a scanning electron microscope (SEM). **Results:** Statistical analysis revealed that specimens with fiber posts demonstrated significantly higher failure loads and favorable fracture pattern compared to the controls. At fractographic analysis, specimens with fiber posts demonstrated delamination of the veneer ceramic from intact zirconia under structure. Meanwhile, the specimens that were restored without a fiber post demonstrated micro-cracking of the composite core build-up resulting in loss of the support under the zirconia crowns which was responsible for the initiation of radial crack and catastrophic damage. **Conclusions:** Within the limitation of this study, the insertion of fiber post improved the support under zirconia crowns which resulted in higher fracture loads and favorable failure type compared to composite core build-up. **PDF**

Salameh, Z, Sorrentin, R, Papacchin, F, Ounsi, HF, Tashkandi, E, Goracci, C, Ferrari, M. **Fracture resistance and failure patterns of endodontically treated mandibular molars restored using resin composite with or without translucent glass fiber posts**. *J Endod. 2006 Aug;32(8):752-5. Epub 2006 Jun 15*

The elastic modulus of the restorative material is important in restoring endodontically treated teeth. This study aimed to compare the fracture resistance and failure patterns of 90 mandibular molars restored using resin composites with or without fiber posts, with respect to the number of residual cavity walls. Five restoration types were performed corresponding to different wall defects (groups 1-5). Groups were divided in two subgroups corresponding to the use or absence of fiber posts. Teeth were loaded and resistance of specimens was measured as the axial compressive load to cause fracture and macroscopic fracture patterns were observed. One way ANOVA revealed a significant difference in fracture resistance ($p < 0.001$). Tukey post hoc test also revealed significant differences between groups as samples restored with fiber posts exhibited mostly restorable fractures. It was concluded that the resistance of endodontically treated mandibular molars restored with composite resins is mainly affected by the number of residual walls. Using fiber-reinforced posts optimized fracture patterns.

Sharma, S, Attokaran, G, Singh, KS, Jerry, JJ, Ahmed, N, Mitra, N. **Comparative evaluation of fracture resistance of glass fiber reinforced, carbon, and quartz post in endodontically treated teeth: An in-vitro study.** *J Int Soc Prev Community Dent. 2016 Jul-Aug;6(4):373-6. doi: 10.4103/2231-0762.186801.*

Aim and objectives: Use of posts improves the physical properties of endodontically-treated teeth. Different post types are developed such as metal, custom-made, carbon, and quartz. The present study was conducted to evaluate the fracture resistance of glass fiber-reinforced, carbon, and quartz post in endodontically-treated teeth. **Methods:** Forty extracted human maxillary incisor teeth were decoronated and endodontically treated and equally divided into 4 groups; control, glass fiber-reinforced, carbon, and quartz posts. No post was used in the control group. Post space was prepared and cemented with different posts and subjected to universal testing machine to check fracture resistance. The data were statistically analyzed using t-test and analysis of variance to compare the mean difference between groups (SPSS version 20, IBM). **Results:** Quartz type of endodontic post showed good fracture resistance compared to carbon and resin-reinforced post. Least resistance was observed in the control group without post. **Conclusion:** Quartz, carbon, and glass fiber-reinforced posts show good resistance to fracture, and hence can be used in endodontically-treated teeth to enhance their strength. **PDF**

Soares, S., Franco, EB., Vidotti, H., Valle, A., Ghizoni, JS, Pereira, JR. **Fracture resistance of different lengths of glass fiber post.** *J Dent Res.Vol 92 (Spec Iss A) Abstract #2343, 2013 (www.dentalresearch.org)*

Objective: The aim of this study was to evaluate the influence of glass fiber post length in the fracture resistance in endodontically treated teeth. Method: It has been selected forty human intact superior canines divided into 4 groups: group I (control), teeth restored with a gold cast post and core with length equal to 2/3 of the root. Other groups received prefabricated glass fiber posts in different length: 1/3, 1/2 e 2/3 of root length (groups II, III and IV, respectively). All posts were cemented with resin cement and the specimens with glass fiber posts received a composed resin core. All samples were restored with a metal crown and submitted to a compressive load until occur failure. Result: The results of this study showed that group I presented a resistance to compressive force statistically higher than the other (634.94 N, 200.01 N, 212.17 N, and 236.08 N, for group I, II, III, and IV, respectively). Although roots restored with cast post and core have supported higher compressive load, all of them fractured in catastrophic manner. Roots restored with glass fiber **Conclusion:** Following the results of this study the length factor did not have relevance for glass fiber posts, but cast post and core with 2/3 of the root length present fracture resistance significant higher than glass fiber posts.

*Sorrentino, R., Monticelli, F., Goracci, C., Zarone, F., Tay, F., Garcia-Godoy, Ferrari, M. **Effect of post –retained composite restorations and amount of coronal residual structure on the fracture resistance of endodontically treated teeth.** *Am J Dent2007;20:269-274*

Purpose: To compare the fracture resistance and failure patterns of endodontically treated teethwith a progressively reduced number of residual walls , restored using resin composites, with or without translucent fiber posts. **Methods:** Ninety extracted human single-rooted maxillary premolars were used. After endodontic treatment, the following groups were created: Group 1 (control group): endodontically treated single-rooted maxillary premolars with four residual walls. Group 2: three residual walls. Group 3:

two residual walls, Group 4: one residual wall, Group 5: no residual wall. Groups 2-5 were each divided into two subgroups: subgroups "a" were restored with resin composites, while subgroups "b" were restored with translucent fiber posts (D.T. Light-Post; RTD St Egreve, France) AND resin composites. Static fracture tests and statistica analyses were performed. **Results:** The mean failure loads (N) were: Group 1=502.4 +/-152.5, Group 2a= 416.4 +/- 122.2, Group 2b= 423.0 +/- 103.3, Group3a= 422.1+/-138.9, Group 3b= 513.2+/-121.7, Group 4a=488.7+/-153.7, Group 4b= 573.4+/-169.2, Group 5a=856.7+/-112.2 and Group 5b= 649.5+/-163.5, respectively. The samples restored with the fiber posts exhibited predominately restorable fractures. The number of residual cavity walls influenced the mechanical resistance of endodontically treated teeth. **PDF**

Sorrentino, R, Salameh, Z, Zarone F, Tay, FR, Ferrari M. **Effect of post-retained composite restoration of MOD preparations on the fracture resistance of endodontically treated teeth**. *J Adhes Dent. 2007 Feb;9(1):49-56*

Purpose: The present study aimed to compare the fracture resistance and failure patterns of endodontically treated premolars with MOD preparations restored using different material combinations. The null hypothesis postulated that there was no association between the fracture resistance of endodontically treated premolars and the resin composite materials or the post-and-core system used to build up the restorations. **Methods:** Eighty single-rooted maxillary premolars were used. After endodontic treatment and preparation of MOD preparations, 8 groups of 10 samples each were created, using the following material combinations: group 1 (control), flowable and microhybrid resin composites; group 2, flowable A; group 3, flowable B; group 4, microhybrid resin A; group 5, microhybrid resin B; group 6, flowable B + microhybrid resin B; group 7, flowable A + microhybrid resin A + post A; group 8, flowable B + microhybrid resin B + post B. Mechanical static fracture tests were performed loading the specimens till fracture. **Results:** The mean failure loads (N) were 502 (control), 470 (group 7), 445 (group 8), 441 (group 6), 405 (group 5), 364 (group 4), 317 (group 2), and 302 (group 3). Statistically significant differences were found between groups 1 vs 2, 1 vs 3, and 3 vs 7 ($p < 0.05$). **Conclusions:** The fracture resistance of endodontically treated premolars with MOD preparations was enhanced by the use of the sandwich technique. The samples restored with posts predominantly showed restorable fractures, while teeth restored without posts mostly displayed unrestorable failures. **PDF**

Vitalariu, AM, Comaneci, R, Tatarciuc, MS. **Prevention of root fracture using posts reinforced with fiber glass.** *Rev Med Chir Soc Med Nat Iasi. 2005 Apr-Jun;109(2):406-11*

The aim of this study was to evaluate the fracture strength and mode of failure of endodontically treated teeth reconstructed with glass fiber reinforced posts. Twenty maxillary central incisors, extracted for periodontal reasons, were divided in 2 groups: gr. 1 - glass fiber posts, and gr.2 - control (endodontically treated but without posts). All samples were embedded in resin blocks and mounted in stainless steel cylinders for the compressive test. The force was applied on oral surface of the crown, until the failure occurred. The compressive loads at failure were recorded and compared with the statistical method Student t. The mode of failure of the specimens were also evaluated. The statistical analysis of the force values showed no significant difference between the groups. In conclusion, because of their low Young's modulus, the non-metallic posts made of resin composite reinforced with glass fibers have a protective effect on the dental tissues, the recorded mode of failure being very similar with the control group.

F . FATIGUE RESISTANCE

*Baldissara, P., Zicari, F., Melilli, D., Monaco, C. **Effect of endodontic treatment on fatigue resistance of fiber post bonding**. *J Dent Res. Vol 82 (Special Issue A) Abstract # 2565, 2003 (www.dentalresearch.org)*

Objectives: The aim of this study is to evaluate the effect of the endodontic treatment on the fatigue resistance of endodontic post adhesive interfaces. **Methods:** FIFTY single-rooted human teeth have been severed at the CEJ and randomly assigned to 5 groups receiving different endodontic treatments as follows: 1) distilled water + gutta percha (control); 2) NaOCl 5% + gutta percha + Pulp Canal Sealer EWT (Kerr); 3) NaOCl 5% + gutta percha + TopSeal (Dentsply-Maillefer); 4) NaOCl 5% and EDTA 10% (alternatively) + gutta percha + Pulp Canal Sealer EWT; 5) NaOCl 5% and EDTA 10% (alternatively) + gutta percha + TopSeal. Subsequently, #2 DT Light-Post (RTD, St Egreve, France /Bisco) quartz fiber posts have been placed in the root canal using All-Bond 2 adhesive (Bisco) and Bis-Fil 2B composite (Bisco). Five specimens from each group have been subjected to 2,000,000 fatigue cycles ranging from 0 to 37.5N at 8Hz frequency and 37^0C water irrigation, whereas the remaining specimens were stored in distilled water at room temp. After the fatigue cycles, all of the specimens were severed obtaining 4 sections from each tooth, which were then evaluated with the push-out test at a constant speed of 1mm/min. Stereomicroscope and SEM observations were done to evaluate the interface failures. **Results:** no statistically significant differences were observed between the 5 groups in both fatigue stressed ($p=0.298$) and water stored specimens ($p=0.093$). Also, the microscope analysis of interface failures showed that the post-cement interface is weaker than the cement-dentin one. The difference was significant with $P=0.001$. **Conclusions:** the results suggest that the interface resistance is not influenced by the canal treatments adopted in this study. Probably the hard tissue removal necessary for post placement eliminated contaminated or altered dentin that may affect the bonding with the luting cement. High resistance of the cement-dentin interface strongly supports this last hypothesis.

*Baldissara, P, Pieri, F, Arcidiacono, A**, Fatigue resistance of fiber posts: a comparative study.** *J Dent Res.Vol. 80 (Special Issue A) Abstract #1434, 2001 (www.dentalresearch.org)*

Fiber posts are commonly used to restore endodontically treated teeth prepared for fixed partial dentures. Their mechanical properties and the use of adhesive cements seem to allow higher survival rates when compared to traditional cast or metal posts. The aim of this study was to compare the fatigue resistance of five different types of fiber posts. Fifty sound incisors, bicuspids and canines have been selected and endodontically treated. The crown was removed and they were randomly divided into five groups. Each group received 10 fiber posts inserted 9mm into the root. The posts were cemented using the dentin adhesive and the cement suggested by the manufacturer: 1) Carbon fiber (Composipost RTD; St Egreve , France / Bisco C-Post); All-Bond 2 / C&B Cement (Bisco), 2) Quartz fiber post Aestheti-Post (RTD; St Egreve , France / Bisco); All-Bond 2 / C&B Cement (Bisco), 3) Quartz fiber Light-Post (RTD, St Egreve , France / Bisco); One -Step (Bisco) and Duo-Link cement (Bisco), 4) Glass fiber FibreKor (Jeneric Pentron) Post; BOND-1 (Jeneric Pentron) and Cement-It! (Jeneric Pentron) , 5) Quartz fiber D T Light-Post (RTD / Bisco); One-Step (Bisco) and Duo-Link cement (Bisco). Post diameter was 1.4mm for groups 1 – 4 and 1.5mm for group 5. Each group was subdivided into a control group and an experimental one. Specimens from the experimental groups underwent 2 million 8Hz frequency load cycles in distilled water at 37^0C. During each cycle, the load ranged from 3 to 21 Newtons and was applied directly one the post in 45^0 direction. The controls were stored in water at 27^0C. After the tests, all the specimens were imbedded in epoxy resin and sectioned transversely, obtaining 1mm thick sections. The sections were observed under the stereomicroscope and the post/cement (PC) and (CD) cement/dentin interfaces were evaluated using an ordinal scale.. One post (Aestheti-Post) fractured after 1.5 million cycles. Light-Post and D. T. Light-Post gave the better results ($P<0.009$) at both interfaces. The PC interface appeared significantly stronger ($P<0.05$) than CD when tested with Kruskal-Wallis test. Significant differences ($P<0.05$) were found between controls and experimentals in groups 4 & 5. It was concluded that Quartz fiber posts are very resistant to fatigue stress and the adhesion at CD interface could be improved.

*Hayashi, M, et al. **Static and fatigue fracture resistance of pulpless teeth restored with post-cores**, *Dent Mater (2008), doj:10.1016/jdental 2008.01.009*

Objectives: Superior restorative methods for effectively strengthening pulpless teeth need to be identified, since vertical root fractures of pulpless teeth are still a major problem in everyday clinical practice. The present study tested the null hypothesis that there were no differences in static and fatigue fracture resistance of pulpless teeth restored with different types of post-core systems. **Methods**: Extracted human premolars were restored with a combination of either a fiber post (D.T. Light-Post #3, RTD, St Egreve, France / Bisco USA) or metallic post and a composite resin core. Teeth with full crown preparations without post-core restorations served as the control. A 90^0 vertical or 45^0 oblique static compressive load was applied to the restored teeth, and (static) fracture loads-and modes of fracture-were recorded. Fatigue fracture tests were conducted by applying sinusoidal cyclic loads to restored teeth from vertical or oblique directions. Fatigue limits for each restoration were calculated using the staircase approach. **Results:** In both static and fatigue fracture testing under vertical or oblique loadings, the fracture loads of the teeth restored with fiber posts were significantly greater thanthose of teeth restored with metallic posts. The fatigue limits of teeth restored with fiber and metallic posts were 112 kgf and 82kgf respectively under vertical loadings, and 26kgf and 20kgf under oblique loadings. **Significance:** the combination of a fiber post and a composite resin core showed superior fracture resistance against both static and fatigue loadings compared to restoration using a metal post and is therefore recommended in restoring pulpless teeth. **PDF**

*Kumar, J., Ng, J.Griggs, Y. Duan, Y. Nagy, W., **Ferrule Effect on Preliminary Cyclic Fatigue of Endodontically Treated Teeth** . *J Dent Res. Vol 89 (Spec. Iss. A) Abstract #657, 2010 (www.dentalresearch.org).*

Objective: Determine the effect of axial tooth structure location on fracture resistance of restored endodontically treated teeth subject to cyclic loading. **Methods:** Fifty extracted maxillary anterior teeth subject to endodontic treatment were divided into five groups. In the complete ferrule group, axial tooth structures were circumferential and complete around the preparation shoulder line. In the palatal, labial and proximal groups, half of the axial tooth structure was removed. These groups were identified by the remaining coronal tooth structures. For the level group, all axial tooth structures were removed to the level of preparation shoulder. All teeth were restored with quartz fiber posts (Bisco/ RTD), composite resin cores (Bisco/ RTD) and metal crowns (Dentsply Ceramco). Teeth were embedded in the acrylic holders, thermally cycled, and then aged for two years in DI water. An electrical circuit was placed across the margin to detect preliminary failure as might lead to microleakage clinically. Specimens were subjected to cyclic fatigue (2Hz, R=0.1) using a servohydraulic load frame under ambient conditions immediately after connecting the circuits. Loading was applied at a 135-degree angle to the long axis of the tooth using step-stress technique. The initial load of 1N was increased by 0.00505N per cycle, and the numbers of cycles at preliminary and ultimate failure were recorded. Results were analyzed by ALTA Pro7 (Reliasoft). **Results:** The statistical analysis indicated that the lifetime data fitted an inverse power law-exponential model, and the cumulative probability of failure was not significantly different among all the five groups ($p=0.076$ preliminary; $p=0.063$ ultimate). The model parameters K and n are summarized in the following table. **Conclusions:** The location of the remaining coronal tooth structure does not affect fatigue resistance. NIH-NIDCR grants DE017991 and DE013358.

Ma, P.S., Nicholls, J.I., **Junge T**, **Phillips KM**. **Load fatigue of teeth with different ferrule lengths, restored with fiber posts, composite resin cores, and all-ceramic crowns.** *J Prosthet Dent. 2009 Oct;102(4):229-34*

Statement of problem: There is no evidence to suggest that the ferrule length needed for an all-ceramic crown is different from that needed for a cast metal or metal ceramic crown**. Purpose:** The purpose of this study was to relate different ferrule lengths with the number of fatigue cycles needed for failure of the crown cement for an all-ceramic crown cemented with a resin cement. **Methods:** Fifteen maxillary central incisors were divided into 3 groups (n=5), with ferrules of 0.0 mm (no-ferrule group), 0.5 mm (0.5-mm ferrule group), and 1.0 mm (1.0-mm ferrule group), respectively. Each tooth was restored with a 0.050-inch glass-filled composite post (ParaPost FiberWhite) and a composite resin core (ParaCore). The posts were cemented with resin cement (Para-Post Cement), and the composite resin cores were bonded to dentin using a dentin bonding agent (ParaPost Cement, Conditioner A & B). Each specimen was prepared with a 7-mm total preparation height, a 1.5-mm lingual axial wall, and a 1.0-mm shoulder around the tooth. The crowns for all specimens were pressed with a pressable ceramic material (IPS Empress 2) and cemented with resin cement (Variolink II). A 6-kg cyclic test load was applied to each specimen at 135 degrees to the long axis of the tooth. The independent variable measured was the number of load fatigue cycles required for failure of the crown cement. The data were subjected to the Kruskal-Wallis test to detect overall significance and the Mann-Whitney U test for pairwise comparisons with Bonferroni correction (alpha=.017). **Results:** The mean (SD) number of cycles to failure for each group was: no-ferrule group, 213 (317); 0.5-mm ferrule group, 155,137 (68,991); and 1.0-mm ferrule group, 262,872 (21,432). None of the specimens in the 1.0-mm ferrule group failed. Significant differences were found between the no-ferrule group and the 0.5-mm ferrule group, and the no-ferrule group and the 1.0-mm ferrule group (P<.017), but not between the 0.5-mm ferrule group and the 1.0-mm ferrule group (P>.017). **Conclusions:** Specimens with a 0.0-mm ferrule survived few fatigue cycles despite the fact that both the post and crown were bonded with resin cement. Teeth with a 0.5-mm ferrule showed a significant increase in the number of fatigue cycles over the 0.0-mm group, whereas teeth with the 1.0-mm ferrule exhibited a significantly higher fatigue cycle count over the 0.0-mm but not the 0.5-mm group. **PDF**

Nie, EM,, Chen, XY, Zhang, CY, Qi, LL, Huang, YH. **Influence of masticatory fatigue on the fracture resistance of the pulpless teeth restored with quartz-fiber post-core and crown**. *Int J Oral Sci. 2012 Dec;4(4):218-20. doi: 10.1038/ijos.2012.78. Epub 2013 Jan 10.*

To investigate whether masticatory fatigue affects the fracture resistance and pattern of lower premolars restored with quartz-fiber post-core and full crown, 44 single rooted lower premolars recently extracted from orthodontic patients were divided into two groups of 22 each. The crowns of all teeth were removed and endodontically treated and then restored with quartz-fiber post-core and full crown. Twenty-two teeth in one group were selected randomly and circularly loaded at 45° to the long axis of the teeth of 127.4 N at a 6 Hz frequency, and the other group was not delivered to cyclic loading and considered as control. Subsequently, all teeth in two groups were continually loaded to fail at 45° to the long axis of the teeth at a crosshead speed of 1 mm/min. (-1). The mean destructive force values were (733.88±254.99) and (869.14±280.26) N for the experimental and the control group, respectively, and no statistically significant differences were found between two groups (P>0.05). Bevel fracture and horizontal fracture in the neck of root were the major fracture mode of the specimens. **Under the circumstances of this study, it seems that cyclic loading does not affect the fracture strength and pattern of the quartz-fiber post-core-crown complex.**

Seseogullari-Dirihan, R., Yahyazadehfar, M., Mutluay, M.,Majd,H. Ryou, H. . Arola, D., Tezvergil-Mutluay, A. **Fatigue resistance of endodontically treated teeth restored with metal-free posts**. *J Dent Res.Vol 92 (Spec Iss A) Abstract #2342, 2013 (www.dentalresearch.org)*

Objective: The aim of this study is to evaluate the contribution of different post configurations to the fatigue resistance of restored endodontically treated teeth. Method: Fifty extracted upper canines were used with anatomical crowns removed. After endodontic treatment, the teeth were randomly distributed into five equal groups: 1) Full-length (3mm from apex) or 2) half-length prefabricated RelyX fiber post #3, 3) full-length or 4) half-length individually formed Everstick fiber post, and 5) box cavity with composite resin only. The posts were cemented using RelyX Unicem self-adhesive resin cement. Standardized composite crowns were built using Z250 restorative composite with a two mm ferrule. After 4 weeks water storage (37°C), the teeth were potted in epoxy resin and loaded cyclically at 30° angle with 2 mm diameter stainless steel rod. Two specimens of each group were tested monotonically to estimate the maximum fracture load. Fatigue testing at 5 Hz was initiated at approximately 85% of the maximum load. For successive specimens the cyclic load was decreased in increments of approximately 50 N. The process continued until reaching the load at which specimens did not fracture within $1.2x10^6$ cycles. The fatigue life distribution was evaluated in terms of the cyclic force and number of cycles to failure. The groups were compared using Wilcoxon Sum Rank Test with $p \leq 0.05$ considered significant. Fracture patterns were also recorded and classified. **Result:** The fatigue resistance of the half-length posts and box cavity only were significantly higher compared to the full length post restorations ($p<0.05$). The primary fracture pattern for all groups was crown-root interface failure. The maximum fracture load ranged between 350 and 1120N and the highest resistance to fracture was found with half-length Everstick. **Conclusion:** Shortening the post length and the ensuing preservation of more tooth structure, offers a viable alternative to full-length posts.

Scotti, R, Valandro, LF, Galhano, GA, Baldissara, P, Bottino, MA. **Effect of post length on the fatigue resistance of bovine teeth restored with bonded fiber posts: a pilot study**. *Int J Prosthodont.. 2006 Sep-Oct;19(5):504-6*

This study evaluated the influence of the cementation length of glass fiber-reinforced composite (FRC) on the fatigue resistance of bovine teeth restored with an adhesively cemented FRC. Thirty roots of single-rooted bovine teeth were allocated to 3 groups (n = 10), according to the ratio of crown length/root length (post cementation length): group 1 = 2/3, group 2 = 1/2, and group 3 = 1/1. The roots were prepared, the fiber posts (FRC Postec Plus) were cemented, and the specimens were submitted to 2 million mechanical cycles. After fatigue testing, a score was given based on the number of fatigue cycles until fracture, and data were submitted to statistical analysis. **All specimens were resistant to fatigue. Taking into account the methodology and results of this study, the evaluated fiber posts can be cemented based on the ratio of crown/root at 1/1. Further clinical studies must be conducted to verify this ratio**. **PDF**

Terakawa, E., Kita, K., Weerasinghe, D. **In-vitro durability of a new glass fiber post.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #4558, 2010 (www.dentalresearch.org)*

Objectives: The purpose of this in-vitro study was to evaluate the durability of a new glass fiber post, "Clearfil™ Fiberpost" (Kuraray Medical Inc., KM). **Methods:** Durability of Clearfil™ Fiberpost was compared with three other commercially available posts of same diameter (1.2~1.3mm); GC Fiberpost (GC Corp.), Tokuy ama FR-Post (Tokuyama Dental Corp.), FibreKor Tapered Post (Pentron Japan Inc.). Five specimens from each of the above groups were checked for three-point flexural strength. Same test was repeated after thermo-cycling (TC, 20.000 cycles 4°C / 60°C, dwell time: 1min, change time: 6s) and flexural strength ratio (post durability) before and after TC was calculated. Similarly thermo-cycled specimens (n>7 for the each group) were pre-treated with approximately 40% phosphoric acid (K Etchant Gel, KM) for 5s, washed and dried. Each post was silane pre-treated (CLEARFIL™ Ceramic Primer, KM) and cemented at a 5mm depth of a prepared cylindrical copper mold space with dual-cure resin cement (Panavia™ F2.0, KM). A 2mm thick rubber spacer was placed on top of the copper mold and core build-up was done (Clearfil™ DC Core Automix, KM). After 24h storage in a 37°C incubator, mold was fixed at an angle of 20 degrees to the long-axis of the post and 5N - 50N cyclic-load applied in-contact mode at 1Hz to the core build-up (Figure1) and fracture resistance was measured by the number of cycles lead to fracture. The flexural strength data was statistically analyzed using ANOVA followed by Scheffe's test (p=0.05). Flexural strength ratio and fracture resistance were analyzed by Mann-Whitney test. **Results:** Different superscripts show a statistically significant difference. **Conclusion:** Within the limits of this study, in-vitro durability of Clearfil™ Fiberpost was significantly higher than the evaluated commercially available fiber posts.

*Wiskott, HWA, et al**. Rotational fatigue-resistance of seven post types anchored on natural teeth. :** *Dent Mater. 2007 Nov;23(11):1412-9. Epub 2007 Jan 30.*

Purpose: To develop a laboratory model aimed at duplicating the failure process of post and core restorations. The load pattern applied was to be repetitive (fatigue) and multivectorial. To determine and compare the resistance under fatigue loading of seven endodontic post/natural root combinations: stainless steel, titanium, ceramic, composite-fiber/epoxy, two glass-fiber/epoxy and glass-fiber/acrylic posts. **Methods:** The repetitive, alternating and multivectorial intraoral force pattern was reproduced by subjecting the specimens to the rotating cantilever beam test. To this end, the samples were designed as rotation-symmetric structures comprising a root, a post, periodontal ligament- and bone analogs and a restoration analog. The following posts were tested: Unimetric-Ti, Unimetric-SS, Biopost, Composipost, Easypost, DT Light-Post, Everstick post. The samples were spun around their long axes while being clamped into a revolving collet on one end and loaded normal to their long axis on the other end. The aim was to determine the load level at which 50% of the specimens survived- and 50% fractured before 10E6 cycles. The 50% means were determined using the staircase procedure. **Results:** In increasing order of magnitude, the resistances to fatigue loading were as follows: Biopost, Unimetric-Ti, Unimetric-SS, Composipost, Easypost, Everstick post, D.T. Light-Post. **Significance:** The fatigue resistance of the two fibrous posts with the highest fatigue resistance (Everstickpost, D. T. Light-Post) was twice that of any of the ceramic or metal posts. **PDF**

*Zamboni, SC, Baldissara, P, Pelogia, F, Bottino, MA, Scotti, R, Valandro, LF**. Fatigue resistance of bovine teeth restored with resin-bonded fiber posts: effect of post surface conditioning.** *Gen Dent. 2008 Jan-Feb;56(1):56-9*

This study evaluated the effect of post surface conditioning on the fatigue resistance of bovine teeth restored with resin-bonded fiber-reinforced composite (FRC). Root canals of 20 single-rooted bovine teeth (16 mm long) were prepared to 12 mm using a preparation drill of a double-tapered fiber post system (D.T. Light-Post; RTD, St Egreve France). Using acrylic resin, each specimen was embedded (up to 3.0 mm from the cervical part of the specimen) in a PVC cylinder and allocated into one of two groups (n = 10) based on the post surface conditioning method: acid etching plus silanization or tribochemical silica coating (30 pm SiO(x) + silanization). The root canal dentin was etched (H2PO3 for 30 seconds), rinsed, and dried. A multi-step adhesive system was applied to the root dentin and the fiber posts were cemented with resin cement. The specimens were submitted to one million fatigue cycles. After fatigue testing, a score was given based on the number of fatigue cycles until fracture. All of the specimens were resistant to fatigue. No fracture of the root or the post and no loss of retention of the post were observed. The methodology and the results of this study indicate that tribochemical silica coating and acid etching performed equally well when dynamic mechanical loading was used.

IV. Adhesion / Retention Testing

A. POST TO ROOT

*Akgungor, G, Akkayan, B. **Influence of dentin bonding agents and polymerization modes on the bond strength between translucent fiber posts and three dentin regions within a post space.** *J Prosthet Dent. 2006 May;95(5):368-78*

Statement of problem: Debonding is the most frequent failure encountered with translucent fiber posts and usually occurs along the post space dentin-adhesive interface. **Purpose:** The purpose of this study was to evaluate the effect of different dentin bonding agents and polymerization modes on the bond strength between translucent fiber posts and root dentin in different regions of the post space. **Methods:** Forty maxillary canines with similar root lengths were selected, sectioned at the cemento-enamel junction, and the roots were endodontically treated. Following post space preparation, the roots were divided into 4 groups of 10 specimens each, and the post spaces were treated with 1 of 4 different dentin bonding agents: light-polymerized, single-bottle bonding agent Excite (Group EX); dual-polymerized, single-bottle bonding agent Excite DSC (Group EX-DSC); self-etching primer Clearfil Liner Bond 2V with a light-polymerized bonding agent, Bond A (Group CL-LC); or self-etching primer Clearfil Liner Bond 2V with a dual-polymerized bonding agent, Bond A+B (Group CL-DC). Translucent fiber posts (D.T. Light-Post, RTD, St Egreve, France), 2.2 mm in diameter, were luted (Panavia F) in each specimen after respective dentin bonding procedures. The roots were cut into 3-mm-thick sections, perpendicular to the long-axis in cervical, middle, and apical post space dentin. Push-out tests were performed with a universal testing machine at a crosshead speed of 0.5 mm/min, and bond strength values (MPa) were calculated by dividing the force at which bond failure occurred by the bonded area of the post. The data were analyzed with 1- and 2-way analysis of variance and Tukey multiple comparison tests (alpha=.05). Dentin adhesive bonding mechanisms in different regions of the post spaces were evaluated with a scanning electron microscope. **Results:** The highest mean bond strength values were obtained for Group CL-LC (18.3 +/- 4.1 MPa). The dual-polymerized bonding agent resulted in significantly lower bond strength (P<.001) in combination with self-etching primer (Group CL-DC) (13.2 +/- 2.5 MPa). The light-polymerized and dual-polymerized single-bottle bonding agents provided similar bond strengths (12.7 +/- 5.0 for EX; 13.5 +/- 5.3 for EX-DSC). The regional bond strength values of single-bottle bonding agents were reduced significantly in apical post space dentin (P<.001). Self-etching primers did not demonstrate regional differences in post space dentin bonding and dense resin tags were apparent. **Conclusions:** Data suggests that the self-etching primer system used in this study was unaffected by the morphological variations in the post space dentin compared to the single-bottle bonding agents. Dual polymerization did not improve the bond strength values of the bonding agents tested. **PDF**

*Aksornmuang, J, Nakajima, M, Foxton, RM, Panyayong, W, Tagami, J. **Regional bond strengths and failure analysis of fiber posts bonded to root canal dentin.** *Oper Dent. 2008 Nov-Dec;33(6):636-43.*

This study evaluated the regional bond strengths of fiber posts to root canal dentin luted with dual-cure resin composite. Twelve extracted human premolars were decoronated and post spaces prepared to a depth of 8 mm. The root canal dentin was treated with Clearfil SE Bond and light-cured for 20 seconds. Three posts from each of the following four types of fiber posts; Snowlight, FibreKor, DT Light-Post and GC Fiber Post-were surface-treated with a mixture of Porcelain Bond Activator and Photobond, then luted into the post spaces with Clearfil DC Core Automix and light-cured for 60 seconds. After 24-hour water storage, each specimen was serially sliced into eight 0.6 x 0.6 mm-thick beams for the microtensile bond strength (microTBS) test. Failure modes were observed using SEM. The microTBS data were divided into coronal and apical regions and statistically analyzed. The highest bond strengths were obtained from FibreKor posts. Regional factors had no effect on bond strength. FibreKor and DT Light-Post specimens primarily failed at the post-resin composite interface, whereas Snowlight and GC Post cohesively failed within the post.

Amaral, M, Rippe, MP, Bergoli, CD, Monaco, C, Valandro, LF. **Multi-step adhesive cementation versus one-step adhesive cementation: Push-out bond strength between fiber post and root dentin before and after mechanical cycling.** *Gen Dent. 2011 Sep;59(5):e185-91.*.

This study evaluated the effects of mechanical cycling on resin push-out bond strength to root dentin, using two strategies for fiber post cementation. Forty bovine roots were embedded in acrylic resin after root canal preparation using a custom drill of the fiber post system. The fiber posts were cemented into root canals using two different strategies (N = 20): a conventional adhesive approach using a three-step etch-and-rinse adhesive system combined with a conventional resin cement (ScotchBond Multi Purpose Plus + RelyX ARC), or a simplified adhesive approach using a self-adhesive resin cement (RelyX U100). The core was built up with composite resin and half of the specimens from each cementation strategy were submitted to mechanical cycling (45 degree angle; 37 degrees C; 88 N; 4 Hz; 700,000 cycles). Each specimen was cross-sectioned and the disk specimens were pushed-out. The means from every group (n = 10) were statistically analyzed using a two-way ANOVA and a Tukey test (P = 0.05). The cementation strategy affected the push-out results (P < 0.001), while mechanical cycling did not (P = 0.3716). The simplified approach (a self-adhesive resin cement) had better bond performance despite the conditioning. The self-adhesive resin cement appears to be a good option for post cementation. Further trials are needed to confirm these results

Ariki, E.K, , Gonçalves, M, Souza, ROA, Z , S.C.,Gia' PEL, Takahashi, F.E., Bottino, M.A, **Resin bond to root dentin: Accessory posts and dentin hybridization effect. *J Dent Res. Vol 87 (Spec. Iss. A) Abstract 1748 (www.dentalresearch.org)*

Objective: To evaluate the influence of accessory fiber posts (AFP) and intraradicular dentin hybridization (IDH) on the push-out bond strength of fiber post luted with resin cement to bovine root dentin. The null hypotheses were that the AFP using and IDH do not affect the push-out bond strength. **Methods:** The canals of forty single-root bovine roots (16mm in length) were prepared at 12mm using the preparation drill (N0 3, RTD, France). With an assistance of a modifier parallelometer, each root had your apical region (4 mm length) embedded in acrylic resin and the roots were randomically divided into four groups, according the luting procedures (N=10): Gr1- IDH + fiber post n0 3; Gr2- IDH + fiber post n0 1; Gr3- IDH + fiber post n0 1 + AFP; Gr4- Fiber post n0 3 without IDH. Except for the group Gr4, the specimens (sps) were treated with the adhesive system (All Bond 2) and the fiber posts (Macro- Lock Illusion) were luted (Duolink) and after stored in distilled water prior the mechanical test (24 h, 37°C). Each specimen was cut in 4 disc samples (1.8 mm in thickness), which were submitted to the push-out test on a universal test machine (EMIC, model DL-1000) at a speed of 1mm/min. The data (MPa) were analyzed statistically by one-way analysis of variance (ANOVA). **Results:** The means (± standard deviation) values obtained after push out test were: Gr1- 5.4±1.3 MPa; Gr2- 4.2±2.4 MPa; Gr3- 4.6±1.5 MPa; Gr4- 3.3±1.7 MPa. The statistical analysis didn't observe influence among the groups (p=0.0966> 0.05). The null hypotheses were accepted. **Conclusion:** The AFP and the IDH do not improve nor diminish the bond strength of fiber post luted to bovine root dentin

Baldissara, P. Monaco , C., Valandro, L.F., . Scotti, R. **Retention of quartz fiber posts using different luting cements *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 976, 2009. (www.dentalresearch.org)*

Objectives: To determine the effect on the pull-out strength of threads cut into the surface of quartz fiber post cemented with three luting materials. Methods: 42 human single-rooted, crownless teeth were treated endodontically and randomly assigned to six fiber posts groups: 1) to 3) were restored with Macro-Lock #3 posts (RTD); 4) to 6) with control posts made of the same material but lacking threads (RTD). The posts were cemented 12mm deep using Panavia(Kuraray), RelyX Unicem (3M ESPE), and Fuji Plus (GC) following the manufacturer instructions. The specimens were subjected to 5000 thermal cycles at 5 and 55°C and wet stored. Retentions were made on the emerging portion of the controls using a diamod bur, then a composite core was made using a mold. A pull-out stress was applied by clamping the core with an Instron machine (2mm/min speed). The pull-out strength was recorded for each group and compared (alpha=0.05). After the test, the specimens were observed under the stereomicroscope to determine failure patterns. Results: The Macro-Lock demonstrated higher retention with all the luting materials employed, statistically significant when RelyX and Fuji were used (P<.05), suggesting that the threads on their surface are effective to improve the pull-out strength. The highest retention of Macro-Locks was obtained using the Fuji GIC and the self-adherent cement (RelyX). The resin cement coupled with an adhesive system (Panavia) showed lower retention forces, probably caused by the "C" factor dynamics. Conclusion: The grooves on Macro-Lock surface are effective to improve the retention; these posts could be used safely with low cost, easy to use materials such as resin modified GIC. Control posts were less retentive, particularly when RelyX Unicem was used. This could be explained by the smooth surface and lack of any thread.

*Baldissara, P., Zicari, F., Melilli, D., Monaco, C. **Effect of endodontic treatment on fatigue resistance of fiber post bonding**. *J Dent Res. Vol 82 (Special Issue A) Abstract # 2565, 2003 (www.dentalresearch.org)*

Objectives: The aim of this study is to evaluate the effect of the endodontic treatment on the fatigue resistance of endodontic post adhesive interfaces. **Methods:** FIFTY single-rooted human teeth have been severed at the CEJ and randomly assigned to 5 groups receiving different endodontic treatments as follows: 1) distilled water + gutta percha (control); 2) NaOCl 5% + gutta percha + Pulp Canal Sealer EWT (Kerr); 3) NaOCl 5% + gutta percha + TopSeal (Dentsply-Maillefer); 4) NaOCl 5% and EDTA 10% (alternatively) + gutta percha + Pulp Canal Sealer EWT; 5) NaOCl 5% and EDTA 10% (alternatively) + gutta percha + TopSeal. Subsequently, #2 D.T. Light-Post (RTD; St Egreve , France /Bisco) quartz fiber posts have been placed in the root canal using All-Bond 2 adhesive (Bisco) and Bis-Fil 2B composite (Bisco). Five specimens from each group have been subjected to 2,000,000 fatigue cycles ranging from 0 to 37.5N at 8Hz frequency and 37^0C water irrigation, whereas the remaining specimens were stored in distilled water at room temp. After the fatigue cycles, all of the specimens were severed obtaining 4 sections from each tooth, which were then evaluated with the push-out test at a constant speed of 1mm/min. Stereomicroscope and SEM observations were done to evaluate the interface failures. **Results:** no statistically significant differences were observed between the 5 groups in both fatigue stressed (p=0.298) and water stored specimens (p=0.093). Also, the microscope analysis of interface failures showed that the post-cement interface is weaker than the cement-dentin one. The difference was significant with P=0.001. **Conclusions:** the results suggest that the interface resistance is not influenced by the canal treatments adopted in this study. Probably the hard tissue removal necessary for post placement eliminated contaminated or altered dentin that may affect the bonding with the luting cement. High resistance of the cement-dentin interface strongly supports this last hypothesis.

*Beriat, N.C., Gülay, G., Yilmaz ,Z., Ertan, A.A. **Bond Strength of fiber posts luted with self etch adhesive.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 970, 2009. (www.dentalresearch.org)*

Objectives: To evaluate the push-out bond strengths of fiber posts luted with self etch self adhesive luting agent. **Methods:** Twenty six extracted single-rooted teeth were randomly divided in two groups and restored using D.T. Light Post and the following luting agents: Variolink II/ExciteDSC/37% phosphoric acid (Ivoclar-Vivadent) and Maxcem (Kerr). For push-out bond strength measurements, thirteen roots per group were tested. Each posted root was cut horizontally into 1mm-thick slices at coronal and apical portions. On every slice the post was loaded by means of an adequately sized punch that pushed the post segment in an apical-coronal direction until the post-root bond failed. This was manifested by the extrusion of the post segment from the root slice, and the load recorded at this time was divided by the area of the post-root interface, in order to express the bond strength in MPa. **Results:** The mean bond strength achieved by Variolink at apical portion (14.77 ± 4.31 MPa), Variolink coronal portion (14.60 ± 4.09 MPa) and Maxcem apical (13.98 ± 4.58 MPa), Maxcem coronal (13.58 ± 4.93 MPa). **Conclusion:** The push-out bond strength was not statistically significantly different between the coronal and apical sections for each luting agent (p>0,005). The highest push-out bond strength was measured for Variolink however it was not statistically significant from Maxcem (p<0,005).

Bergoli, CD, Amaral, M, Druck, CC, Valandro, LF. .**Evaluation of four cementation strategies on the push-out bond strength between fiber post and root dentin**. *Gen Dent. 2011 Nov;59(6):498-502*

This trial used push-out testing to evaluate four different fiber post cementation strategies. Specimens of bovine mandibular teeth were randomly allocated into four groups according to cementation strategies (n = 10): ScotchBond MultiPurpose and RelyX ARC (Group 1); AdheSE and Multilink Automix (Group 2); phosphoric acid and RelyX U100 (Group 3); and RelyX U100 (Group 4). Four slices from each specimen (2.0 mm thick) were obtained for the push-out test. All slices were analyzed for failure mode after testing. A one-way ANOVA showed differences between the groups (P = 0.002). A Tukey test indicated that Group 1 had the highest bond strength values (13.96 ± 6.41 MPa). Groups 2 (6.58 ± 2.14 MPa), 3 (5.85 ± 2.57 MPa), and 4 (8.19 ± 2.28 MPa) had similar bond strengths, but all of them were lower than Group 1. **Conclusions:** A three-step total etching adhesive system, associated with a conventional resin cement, might be a good alternative for fiber post cementation.

*Beriat, N.C., Ertan, A.A., Yilmaz, Z., Gulay, G., **Effects of different luting cements and light curing units on the sealing ability and bond strength of fiber posts.** *Dent Mater J. 2012;31(4):575-82.*

This study evaluated the sealing ability and push-out bond strength of two luting cements cured with two different types of light curing units (LCU): light-emitting diode (LED) versus quartz tungsten halogen (QTH). Forty teeth were divided into four groups (n=10/group). Quartz fiber posts (D. T. Light-Post, RTD St Egreve, France) were luted to coronal or apical section of root canals using two types of resin cements (Panavia F or RelyX) cured with either LED LCU (Elipar FreeLight II) or QTH LCU (Optilux 501). Highest push-out bond strength was exhibited by QTH-cured RelyX, which was not significantly different from LED-cured RelyX but was higher than QTH cured Panavia F. The push-out bond strength of Panavia F did not differ with LCU type (p>0.05), but exhibited lower values than both QTH- and LED-cured RelyX. Fluid filtration test revealed that sealing ability was not influenced by luting cement type, but was significantly influenced by LCU type in favor of QTH light source: QTH-cured specimens displayed better seal than LED-cured ones (p<0.05).

Bitter, K, Perdigão, J, Exne,r M, Neumann, K, Kielbassa, A, Sterzenbach, G. **Reliability of fiber post bonding to root canal dentin after simulated clinical function in vitro.** *Oper Dent. 2012 Feb 16. [Epub ahead of print]*

The aim of this study was to investigate the effect of thermo-mechanical loading (TML) on the bond strength of fiber posts luted with three different resin cements. Sixty-six extracted human anterior teeth were endodontically treated and restored with fiber posts (Rely-X Fiber Posts, 3M ESPE) using three commercially available resin cements and three corresponding core build-up materials (n=22 each): Panavia F 2.0/Clearfil DC Core Automix (Kuraray), Variolink II/Multicore Flow (Ivoclar Vivadent), and RelyX Unicem/Filtek Z250 (3M ESPE). Twelve specimens of each group received all-ceramic crowns and were subjected to TML. The other 10 specimens were stored in saline solution for 24 hours. The roots were sectioned and bond strength was measured using a push-out test. Adhesive interfaces of two specimens of each group subjected to TML were analyzed using field emission scanning electron microscopy (FESEM). Bond strengths of fiber posts were significantly affected by the type of resin cement (p<0.0005) and TML (p<0.0005; two-way analysis of variance). TML significantly reduced bond strengths for all materials ((6.0 (6.2) MPa)) compared with initial bond strengths ((14.9 (10.4) MPa)). RelyX Unicem resulted in significantly higher bond strengths before ((18.3 (10.3) MPa)) and after TML ((9.8 (7.5) MPa)) compared with the other materials (p<0.0005; Tukey HSD). Using FESEM, Variolink II and Panavia F demonstrated a hybrid layer partly detached from the underlying resin cement, whereas no hybrid layer was observed for RelyX Unicem. The decrease in bond strength after TML suggests that retention of fiber posts may be reduced after clinical function. Therefore, endodontically treated teeth that are restored using fiber posts may benefit from additional reinforcement via coronal restorations using adequate ferrules and/or adhesive techniques.

Boff, LL, Grossi, ML, Prates, LH, Burnett ,LH, Shinkai ,RS. **Effect of the activation mode of post adhesive cementation on push-out bond strength to root canal dentin**. *Quintessence Int. 2007 May;38(5):387-94*

Objective: To evaluate the effect of the activation mode of adhesive cementation on push-out bond strength of fiber-reinforced resin posts to root canal dentin. **Methods:** Forty mandibular premolars were endodontically treated and randomly divided into 4 equal groups. In groups G-1, G-2, and G-3, Single Bond (3M Espe) was applied and light polymerized for 20 seconds; in group G-4, Scotchbond Multi-Purpose Plus (3M Espe) was used as an autopolymerized adhesive. The dual-cure resin cement RelyX ARC

(3M Espe) was light polymerized in G-2 and G-3 but not in G-1 and G-4. The translucent post Light-Post (RTD, St Egreve, France /Bisco) was used in G-3 and the opaque post Aestheti-Plus (RTD, St Egreve, France /Bisco) in the other groups. The roots were sectioned in 3 parts (cervical, middle, apical); each slice was submitted to the push-out test at a crosshead speed of 0.5 mm/min. Data were analyzed by analysis of variance and Tukey test (a = .05). **Results:** Light polymerization of both the adhesive and resin cement in G-2 led to significantly higher bond strength than in G-1, where only the adhesive was light polymerized. No difference was found between G-2 (opaque post) and G-3 (translucent post). The autopolymerized adhesive showed the highest bond strength in all root regions. The middle and apical post/root regions had similar bond strength, but it was significantly lower than that in the cervical region (P <.001). **Conclusion:** Bond strength to root dentin varied as a function of the activation mode of post adhesive cementation and post/root regions

Bolhuis P, de Gee A, Feilzer A**. Influence of fatigue loading on four post-and-core systems in maxillary premolars.** Q*uintessence Int. 2004 Sep;35(8):657-67.*

Objective: Clinical studies show a high failure incidence after years of service of endodontically treated premolars, when restored with post-core crowns, especially those with short posts or deficient ferrules. The reason for this can be a deterioration of the luting cement around the post by fatigue from functional loading. In particular, the anatomy of premolars may frequently be incompatible with the application of long endodontic posts. The aim of this study was to evaluate the influence of fatigue loading on the quality of the cement layer between posts with restricted lengths and the root canal wall in premolars. As the stiffness of posts may affect the outcome, post-and-core systems with varying post stiffness were selected. **Methods:** Four types of post-and-core systems were selected for this study: three prefabricated post systems combined with a resin composite core material and one cast post and core. The three prefabricated posts were titanium posts (Tenax), quartz-fiber posts (Aestheti-Post, RTD, St Egreve, France), and quartz-coated-carbon-fiber posts (Aestheti-Plus, RTD, St Egreve, France). The post-and-core restorations were made on single-rooted, human, maxillary premolars from which the coronal sections were removed at the level of the proximal cementoenamel junction. Following endodontic treatment, a cast post and core (post length 6 mm) was prepared for each tooth individually (direct method) and cemented into the root canal with chemical cure Panavia 21 TC. The prefabricated posts were directly cemented in the root canal and then, after applying a dual-cure adhesive (Clearfil Photobond), built up with a core build-up composite (Clearfil Photocore). For each group (n = 8), half of the specimens were exposed to fatigue loading (10(6) load cycles) almost perpendicular to the axial axis (85 degrees), while the other half was used as the control. Three parallel, transverse root sections of 1.5-mm thickness, were cut from each specimen. These sections were examined by scanning electron microscopy (SEM) to evaluate the cement integrity, while the retention strength of the cemented post sections was determined with a push-out test. **Results:** Fatigue loading did not cause separation of the buildups from the roots or affect the push-out strength. On a univariate level, only SEM evaluation showed significant differences between the types of post, fatigue loading, and between the levels of root sections. The cement integrity with the titanium post was significantly less than with the other three systems, which did not differ among themselves. **Conclusions:** A composite core build-up material bonded to the dentin and supported by quartz-fiber posts or quartz-coated-carbon-fiber posts, cemented with adhesive cement may be a viable alternative for the conventional cast core.

*Borer, R., Leandro, R and Haddix, J. **Effect of dowel length on the retention of two different prefabricated posts.** *Quintessence Int. 2007;38:173.e164-168*

Objectives: to compare the in vitro retentive values of stainless steel, parallel sided posts to quartz fiber tapered posts for two different dowel lengths (5mm and 10mm). **Methods:** Both post systems were cemented with a dual-cure adhesive resin cement. Single rooted extracted human teeth (n-40) were de-coronated and randomly divided into 4 groups of 10 samples each. Posts of 5 and 10mm in length were luted with the resin cement. Each sample was placed on a universal testing machine, and using a push-out method, a vertical load was applied at a crosshead speed of 2mm/min. The amount of force required to dislodge the post was recorded. The effect of post type and length was evaluated using a 2-way analysis of variance. **Results:** A statistically significant main effect was found for post length (P<.001) with the 10mm posts of both post systems requiring greater force to dislodge than the 5mm posts. There was no interaction between post length and post type (P>.05). **Conclusions**: It is concluded from this study that there is no statistical difference in retention between quartz fiber tapered posts (D. T. Light-Post; RTD, St Egreve, France) and stainless steel parallel-sided posts (ParaPost, Coltene Whaledent, Cuyahoga Falls, OH USA) when they are cemented with the same resin cement (P> .05). The study also concludes that adequate retentive values are achieved with both systems at the shorter, 5mm post length. **PDF**

*Bottino, MA, Baldissara, P, Valandro, LF, Galhano, GA, Scotti, R. **Effects of mechanical cycling on the bonding of zirconia and fiber posts to human root dentin.** *J Adhes Dent. 2007 Jun;9(3):327-31.*

Purpose: To evaluate the effect of cyclical mechanical loading on the bond strength of a fiber and a zirconia post bonded to root dentin. **Methods:** Forty single-rooted human teeth (maxillary incisors and canines) were sectioned, and the root canals were prepared at 12 mm. Twenty randomly selected specimens received a quartz fiber post (FRC) (D.T. Light-Post; RTD, St Egreve, France) and 20 others received a zirconia post (ZR) (Cosmopost). The posts were resin luted (All Bond 2 + resin cement Duolink) and each specimen was embedded in epoxy resin inside a PVC cylinder. Ten specimens with FRC post and 10 specimens with ZR post were submitted to fatigue testing (2,000,000 cycles; load: 50 N; angle of 45 degrees; frequency: 8 Hz), while the

other 20 specimens were not fatigued. Thus, 4 groups were formed: G1: FRC+O cycles; G2: FRC+2,000,000 cycles; G3: ZR+O cycles; G4: ZR+2,000,000 cycles. Later, the specimens were cut perpendicular to their long axis to form 2-mm-thick disk-shaped samples (4 sections/specimen), which were submitted to the push-out test (1 mm/min). The mean bond strength values (MPa) were calculated for each tooth (n = 10) and data were submitted to statistical analysis (alpha = 0.05). **Results:** Two-way ANOVA revealed that the bond strength was significantly affected by mechanical cycling (p = 0.0014) and root post (p = 0.0325). The interaction was also statistically significant (p = 0.0010). Tukey's test showed that the mechanical cycling did not affect the bonding of FRC to root dentin, while fatigue impaired the bonding of zirconium to root dentin. **Conclusion:** (1) The bond strength of the FRC post to root dentin was not reduced after fatigue testing, whereas the bonding of the zirconia post was significantly affected by the fatigue. (2) Cyclical mechanical loading appears to damage the bond strength of the rigid post only.

Calixto, LR, Bandéca, MC, Clavijo, V, Andrade, MF, Vaz, LG, Campos, EA. **Effect of resin cement system and root region on the push-out bond strength of a translucent fiber post.** *Oper Dent. 2012 Jan-Feb;37(1):80-6. Epub 2011 Sep 26.*

Objectives: This study evaluated the bond strength of luting systems for bonding glass fiber posts to root canal dentin. The hypothesis tested was that there are no differences in bond strength of glass fiber posts luted with different cement systems. **Methods:** Forty bovine incisors were randomly assigned to five different resin cement groups (n=8). After endodontic treatment and crown removal, translucent glass fiber posts were bonded into the root canal using five different luting protocols (self-cured cement and etch-and-rinse adhesive system; dual-cured cement and etch-and-rinse adhesive system; self-cured cement and self-etch adhesive system; dual-cured cement and self-etch adhesive system; and dual-cured self-adhesive cement). Push-out bond strength was evaluated at three different radicular levels: cervical, middle, and apical. The interface between resinous cement and the post was observed using a stereoscopic microscope. **Results:** Analysis of variance showed a statistically significant difference among the cements ($p<0.05$) and the root canal thirds ($p<0.05$). The self-adhesive resinous cement had lower values of retention. **Conclusions:** The resin cements used with etch-and-rinse and self-etch adhesive systems seem to be adequate for glass fiber post cementation.

*Coniglio, I, Magni, E, Cantoro, A, Goracci C, Ferrari M. **Push-out bond strength of circular and oval-shaped fiber posts.** *Clin Oral Investig. 2010 Jul 27. [Epub ahead of print]*

This study aimed at evaluating the post-root dentin push-out bond strength of circular and oval posts luted in oval-shaped canals with two different resin cements. Twenty extracted premolars with oval-shaped canals were selected, endodontically instrumented and obturated. The teeth were divided into two groups according to the drill used for post-space preparation and to the post shape (Ellipson oval tip + post and MTwoPF + DT Light-Post). Each group was then subdivided into two subgroups according to the cement (Gradia Core and Corecem Automix). The post-dentin bond strength was evaluated with the thin-slice push-out test. The bonded surface area was calculated for each post shape with an appropriate geometric formula in order to express the retentive strength in megapascal. Push-out strength data were analyzed with the Kruskal-Wallis ANOVA. The results showed that neither the drill-post system nor the cement significantly affected the push-out strength. The means (SD) of the push-out bond strengths in the experimental subgroups were the following: 11.79 MPa (4.77) for Gradia Core/Ellipson tip and post, 13.36 MPa (5.16) for Gradia Core/MtwoPF and **DT Light-Post,** 11.18 MPa (2.58) for Corecem Automix/Ellipson tip and post, and 10.91 MPa (3.89) for Corecem Automix/MtwoPF and DT Light-Post. In conclusion, circular and oval posts achieved similar retentive strengths in oval canals.

Cury, AH, Pegoraro, TA,. Pereira, JC, Suh, BI, Carvalho, RM. **Effects of polymerization-mode on the push-out retention of self-adhesive resin-cements** *J Dent Res. Vol 87 (Special Issue A) Abstract # 0379, 2008 (www.dentalresearch.org)*

Objectives: To evaluate push-out retention strength of fiber posts cemented with two self-adhesive resin cements (RelyX Unicem, 3M ESPE and Biscem, Bisco Inc.) under different curing modes (dual-cured or self-cured), on each regional root-third. **Methods**: Twenty extracted human teeth were endodontically treated. Post space was prepared and cleaned (5% sodium hypochlorite), and roots were assigned to four groups (N=05): *Group 1*: Unicem light-cured; *Group 2*: Unicem self-cured; *Group 3*: Biscem light-cured; *Group 4*: Biscem self-cured. A Light-cure unit (VIP, Bisco, Inc.) was employed to irradiate the coronal aspect of each tooth for 20 sec@600mW/cm^2. For the self-cured mode, teeth were allowed to dark cure at 37 ^{o}C for 6 minutes. Each root was cut horizontally into 1mm-thick slices. A universal testing machine Vitrodyne V-1000 (Chatillon Force Measurement Systems) was utilized with a custom-made cylindrical plunger (0.79 mm diameter), which was positioned on the apical face of the root slice. The loading was applied (0.5mm/min) until complete post displace and extrusion from root slice. The results were calculated and expressed as the bond strength in MPa. **Results:** MPa±SD (N). Data were analyzed by ANOVA and Tukey Test ($p<0.05$). ANOVA revealed that "polymerization mode" and interaction of "cement" and "polymerization mode" had significant influences on the push-out strength ($p<0.05$). **Conclusion**: For some dual-cured resin-cements light-activation is further important to achieve optimal properties. When the self-cure mode was used highest values were recorded on the apical third.

Dallari, A, Rovatti, L, Dallari, B, Mason, PN, Suh, BI. **Translucent quartz-fiber post luted in vivo with self-curing composite cement: case report and microscopic examination at a two-year clinical follow-up.** *J Adhes Dent. 2006 Jun;8(3):189-95*

A maxillary central incisor with mild periodontitis and extensive loss of coronal tooth structure was endodontically treated and restored with a translucent quartz-fiber post and a composite core. Treatment was completed with the cementation of full-ceramic

crowns on teeth 11 and 21. Informed consent was obtained from the patient. Due to the extent of the periodontal disease, tooth 11 was extracted two years later. With the patient's consent, the tooth was used for research. The tooth was sectioned at 11 levels perpendicularly to the long axis and investigated by means of optical microscopy and scanning electron microscope (SEM). The visual examination showed perfect adhesion between the various interfaces (restoration-dentin-post) at both the coronal and root levels. The adhesion between the post and dentin appeared to be free of gaps, and even where the composite cement showed a nonhomogeneous thickness, voids were not apparent. The tooth under examination allowed the authors to check the effectiveness of the adhesion and the integrity of the hybrid layer after exposure to the oral cavity for two years. The results of this investigation show that there were no gaps between the adhesive resin and dentin and no hydrolysis of the adhesive bond. This case suggests that it is possible to obtain good results in the short term from the cementation of quartz-fiber posts with composite resin cements.
PDF

Dallari, A., Mason, P., Rovatti, L., Dallari, B. **Effect of surface treatments on retention of quartz- fiber posts. *J Dent Res. Vol 87 (Spec. Iss. C) Abstract #0383, PEF Division 2008 (www.dentalresearch.org)*

The use of quartz fiber-reinforced posts, adhesively luted into root canal, has increased in popularity for the post-endodontic restorations. Objectives: The aim of this in vitro study is to verify the influence of different surface pre-treatments on micro-tensile bond strength between quartz posts and composite luting cement. Methods: 50 quartz fibers posts (40 DT Light-Post, RTD, France + 10 Macro-Lock Post, RTD, France) have been subdivided into 5 groups: 1) 10 DT Light-Post with no surface treatment (as control). 2) 10 DT Light-Post pre-treated with hydrofluoric acid 9.6 % for 15 sec. 3) 10 DT Light-Post coated with industrial procedure by the factory. 4) 10 DT Light-Post pre-treated with methyl-methacrylate for 1 minute. 5) 10 Macro-Lock Post, with carved surface and not subjected to chemical pre-treatments. Posts have been luted using the same composite cement (BisCem, Bisco, USA) in plastic cylinders (Endo Trainers, Frasaco, USA), and slices 2.0 mm thick have been obtained with a diamond wheel (Leitz 1600). Slices have been subjected to pull-out test with Instron Machine. Results: Group 1: 13.28 MPa; Group 2: 24.60 MPa; Group 3: 26.90 MPa; Group 4: 34.20 MPa; Group 5: 32.05 MPa. Conclusions: All the post-surface pre-treatments lead to a real (double or more) improvement of tensile bond strength values. Macro-retention provided by carving of the surface (Macro-Lock Post) and micro-retention obtained with methyl-methacrylate pre-treatment reached the highest results.

*Dimitrouli, M, Geurtsen W, Lührs AK. **Comparison of the push-out strength of two fiber post systems dependent on different types of resin cements.** *Clin Oral Investig. 2011 Jun 7. [Epub ahead of print]*

The purpose of this study was to compare the push-out strength of glass fiber posts dependent on the resin cement. One hundred human teeth were divided into five groups (n = 20). Two glass fiber post systems (DT Light SL (DTSL) and Rely-X Fiber Post (RF)) were used. DTSL posts were cemented with one "etch & rinse" system (ER) or one of three self-adhesive resin cements (SA). The RF posts were cemented with Rely-X Unicem. Afterwards, half of the specimens were thermocycled (TC; 5°C/55°C, 5,000 cycles). All specimens were cut into disks (thickness, 2 mm). The push-out test was performed (crosshead speed, 1 mm/min), fracture types were determined (×25 and ×40 magnification), and statistical analysis was performed (one-way analysis of variance (ANOVA), Scheffe test, $p < 0.05$). One-way ANOVA showed a significant influence of the resin cement on the push-out strength of the glass fiber posts before thermocycling ($p < 0.001$). After TC, no significant differences were detected. Microscopic evaluation showed mainly adhesive failures between post and cement for ER or mixed fractures for SA. The bond strength of adhesively cemented glass fiber posts is not dependent on the type of resin cement after TC. The use of SA can lead to bond strength values comparable to ER. Self-adhesive resin cements could be used just as well as resin cements with "etch & rinse" adhesive systems for the cementation of glass fiber posts.

*Dulla, M., Lussi, A., Zimmerli, B. **Influence of root-canal sealer and luting-cement on fibre-post adhesion.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #3980, 2010 (www.dentalresearch.org)*

Objectives: To investigate the effects of three different luting-cements and two root-canal sealers on bond strength of fibre-posts. **Methods:** Sixty extracted maxillary molars were divided into two groups (n=30). The teeth were endodontically treated and filled with Gutta-percha and root-canal sealer (group 1: AHplus, group 2 : EndoREZ). Only the palatinal roots were treated, whereas the other roots were removed. The specimens were thermocycled (5000x; 5-55°C) and each group was divided into three subgroups A-C (A: RelyX Unicem, B: Multilink Automix, C: Calibra and XP Bond) (n=10). Quartz fiber-posts (D.T. Light-Post) were cemented. A standardized composite build-up was placed (Core-Xflow). All specimens were fatigue-cycled (1'200'000x; 49N; 1.6Hz), thermocycled (5000x; 5-55°C) and subsequently stored for one year. Push-out bond-strength was measured on four 1mm slices per specimen (coronal and apical root region) at a crosshead speed of 1mm/min. Fracture analysis was performed by light-microscopy. Statistical differences were analyzed with ANOVA and pairwise Wilcoxon signed rank test (a=0.05). Groups with the same superscript are not statistically significant different. Bond-strengths values were significantly affected by luting-cement and root-canal sealer ($p<0.05$). Additionally, there was a significant interaction between luting-cement and root-canal sealer ($p<0.05$). RelyX Unicem showed significantly higher bond-strengths compared with all other materials. EndoREZ showed significant higher bond-strengths in all groups compared with AHplus. Root region had no significant effect ($p>0.05$). Microscopical analysis revealed a prevalence of adhesive failures at the post-cement interface, except for groups 2A and 2C whereas mainly cohesive failures within the post occured. **Conclusion:** Resin-based root-canal sealers can increase bond-strengths of fibre-posts. The self-adhesive luting-cement showed good performance after artificial aging procedure.

*Ertan, A.A., Beriat, N. C., Yilmaz, Z. **Push-out bond strength of a novel fiber metal post.** *J Dent Res. Vol 89(Spec. Iss. B) Abstract #4495, 2010 (www.dentalresearch.org)*

Objectives: The aim of this study was to evaluate the regional push-out bond strengths for two post types using two different resin cements. **Methods:** Twenty-four single-rooted, extracted human teeth were selected and the crowns were sectioned off to obtain roots with standardized length (18mm). The roots were obturated with gutta-percha using lateral condensation. The teeth were randomly divided into four experimental groups (n=6/group). Roots were restored with a quartz fiber post (D.T. Light Post) and fiber metal posts (Spirapost), which were cemented with two different resin cements. After 1 week of water storage at 37º C, 1mm-thick sections were prepared from each specimen for push-out bond strength testing. Push-out tests were performed at a crosshead speed of 0.5 mm/min. The data were analyzed with ANOVA. Results: Quartz fiber posts demonstrated significantly higher push-out bond strengths than fiber metal posts ($p < 0.001$). Bond strength values decreased significantly from the cervical to the apical root canal regions ($p < 0.001$). **Conclusion:** In conclusion, in all root segments, the quartz fiber posts provided significantly increased post retention than the fiber-metal post, regardless of the adhesive used.

Ferrari, M, Carvalho, C.A,, Goracci, C., Antoniolli, F., Mazzoni, A., Mazzotti, G., Cadenaro, M., Breschi ,L. **Influence of luting material filler content on post cementation.** *J Dent Res. 2009 Oct;88(10):951-6.*

Luting of fiber posts to intra-radicular dentin represents the worst-case scenario in terms of control of polymerization shrinkage. This study tested the hypothesis that filler content of resin cements does not influence luting of fiber posts to intra-radicular dentin, by assaying polymerization stress, push-out bond strength, and nanoleakage expression. The polymerization stress of experimental cements containing 10%, 30%, 50%, or 70% in filler content was investigated. Post spaces were prepared in endodontically treated teeth, and fiber posts were cemented with the experimental cements. A push-out test was performed, and interfacial nanoleakage expression was analyzed. Results showed that luting cements with higher filler content were related to increased polymerization stress ($p < 0.05$), decreased push-out bond strength ($p < 0.05$), and increased interfacial nanoleakage expression ($p < 0.05$). Conversely, lower-stress luting materials increased bonding of fiber posts to intra-radicular dentin. Further in vivo studies are needed to investigate the long-term clinical performance of these materials. **PDF**

*Gernhardt, CR, K. Bekes, K., Schaller, HG . **Effect of different fibre post diameters on retentive strength**. *J Dent Res (Special Issue A) #1586, 2006 (www.dentalresearch.org)*

Objectives: The retention of endodontic posts is believed to be a major factor in restoration survival. The purpose of this study was to evaluate the effect of post diameter on the bond strength of the fiber post D.T. Light-Post using two different cements. **Methods**: Sixty caries free human incisors were selected for standardized size and quality, endodontically treated and coronally reduced to the cemento-enamel junction. The specimens were randomly assigned to three experimental groups: (I): canal preparation with DT drill #1, insertion of DT Light Post #1, (II): canal preparation with DT drill #2, insertion of DT Light Post #2; (III) canal DT drill #3, insertion of DT Light Post #3. The fibre posts were cemented using either Calibra (subgroup C) or Panavia F (subgroup P). Retentive strength was measured 24 hours after cementation using a universal testing machine. Data were analyzed with SPSS 10.0. **Results:** The following mean retentive strengths were evaluated. Statistical analysis showed that the post diameter did not affect the bond strengths the fibre posts of the D.T. Light Post system ($p< 0.05$, Tukey test). Posts cemented with Panavia showed higher bond strengths. In the case of size 3 posts this difference was significant ($p< 0.05$, Tukeyxs test). **Conclusions:** The reconstruction of endodontically treated single rooted teeth with fibre posts showed acceptable retentive values for both cements used in this in vitro study. The post diameter did not affect the bond strengths of the D.T. Light-Post system (RTD, St Egreve, France).

Galhano, G., Melo, R. M., Valandro, L. F., Bottino, M. A., Baldissara, P., Scotti, ' R, **Mechanical cycling of ceramic and FRC posts bonded to root-dentin.** *J Dent Res. Vol 85 (Spec. Iss. B) Abstract #0660, 2006 (www.dentalresearch.org).*

Objectives: This study aimed to evaluate the effect of mechanical cycling on the adhesive bond strengths at the root dentin/resin cement and resin cement/ceramic post interfaces. **Methods:** Forty single rooted human teeth were transversally sectioned, with 16mm left for specimens. The canal preparation of 20 teeth was performed to receive a 12mm high ceramic post (Cosmo Post, Ivoclar) and another 20 teeth were prepared to receive a fiber reinforced post (FRC Postec, Ivoclar). The canals were treated with All-Bond 2 (Bisco) chemical polymerizable adhesive system and Duo-Link dual resin cement (Bisco). After that, ten specimens of each post were subjected to 2,000,000 mechanical cycles. A 1,6 mm thick punch induced loads of 37,5Kg, at 45° angulation to the long axis of specimens and frequency of 8Hz, on the posts. To evaluate the bond strengths, the specimens were sectioned perpendicular to the long axis of teeth, generating slices of about 2mm (5 sections per teeth), which were subjected to the push-out test in a universal testing machine, EMIC, at 1mm/min crosshead speed. The mean bond strength was taken to each tooth and ten values per group (n=10) were subjected to statistical analysis. **Results:** The Tukey test (5%) showed that the mean of the ceramic group subjected to the mechanical cycling (3,2577 ± 2,3345) was different to both ceramic control group (7,6819 ± 1,2628), Fiber reinforced group subjected to the mechanical cycling (6.901±1.930) and Fiber reinforced control group (6.823±2.214) . These three last groups did not differ statistically. **Conclusion:** It was possible to conclude that the mechanical cycling of ceramic posts reduced the bond strengths at the root dentin/resin cement and resin cement/ceramic post interfaces.

Gernhardt, C., Fiedler, T, Widera, M., Schaller, H-G. **Influence of different cementation modalities on retention of fibre posts.** *J Dent Res. Vol 81 (Spec. Iss. A) Abstract #0421, 2002 (www.dentalresearch.org).*

Objectives: The retention of endodontic posts is believed to be a major factor in restoration survival. The aim of this study was to compare the retentive strength of fibre posts cemented with two different cements in combination with different pre-treatments. **Methods:** Forty caries free human maxillary incisors were selected for standardized size and quality, endodontically treated and coronally reduced to the cemento-enamel junction. During the experimental period the teeth were stored in saline. All specimens were randomly assigned to four experimental groups of ten samples each. In group A the fibre posts were sand-blasted and cemented with Panavia F. In group B the posts were cemented without sand-blasting. Group C received sand-blasted fibre-posts cemented with Ketac-Cem. In group D the posts were cemented without sand-blasting. Post holes were prepared according to manufacturers' instructions. The fibre posts (Mirafit Carbon) were then cemented with one of the two cements as recommended. Retentive strength was measured 24 hours after cementation using a universal testing machine. **Results:** The following mean retentive strengths in Newtons for the different groups were: group A: 448.4 N (+/- 105.9 N); group B: 395.7 N (+/- 99.9 N); group C: 210.9 N (+/- 66.5 N); group D: 176.8 N (+/- 67.2 N). Retentive strength in group A and B (Panavia F) was significantly increased compared to group C and D (Ketac-Cem) ($p< 0.05$, Tukey xs test). The influence of sandblasting was for both cements not significant. **Conclusions:** The reconstruction of endodontically treated single rooted teeth with fibre posts showed acceptable retentive values for all cementation modalities used in this study. The values observed for the composite cement Panavia F were significantly higher compared to the conventional cement Ketac-Cem.

*Giovannetti, A, Goracci, C, Vichi, A, Chieffi, N, Polimeni A, Ferrari, M. **Post retentive ability of a new resin composite with low stress behaviour.** *J Dent. 2012 Apr;40(4):322-8. Epub 2012 Jan 25.*

Objectives: To assess by means of push-out test the post retentive potential of a new flowable resin composite with low polymerization stress. **Methods:** SureFil(®) SDR™ (Dentsply, S) was compared with the resin cement Calibra (Dentsply, C). S and C were used in combination with the adhesive XP Bond (Dentsply, XPB). In C group the Self-Cure Activator was mixed with XPB. The following types of fibre posts were luted into 30 extracted premolars: Radix Fiber Post (Dentsply, R), DT Light-Post (RTD, LP), ER Dentin Post (Komet, ER), DT Light SL (VDW, SL), FibreKleer (Jeneric Pentron, F). Six posted roots per group were tested. Each root provided three to five 1mm-thick slices. Measured push-out strengths were differentiated by post space level and statistically analysed ($p<0.05$). The failure mode of each debonded specimen was assessed. **Results:** Cement type did not have a significant effect on post retention ($p=0.54$). Post type was a significant factor for push-out strength ($p<0.001$). LP exhibited significantly higher retentive strength than SL and F; push-out strengths of ER and R were significantly higher than those of F. Postretention was significantly influenced by post space level ($p<0.001$). Significantly higher push-out strengths were recorded at the coronal third than at the middle and apical levels. The post-cement interaction was significant ($p=0.002$). Posts luted with S most often failed at the cement-post interface. **Conclusions:** When the new flowable low-stress composite was used to lute fibre posts, similar retentive strengths to those of a marketed cement from the same manufacturer were achieved. SureFil(®) SDR™, a flowable composite originally proposed for bulk filling of posterior restorations, exhibited postretentive strengths similar to those of a cement by the same manufacturer. With a relatively high filler load, yet a low curing stress, SureFil(®) SDR™ may be adequate for both post cementation and core build-up.

Goto, Y., Nicholls, J. I., Phillips, K., Junge, T., **Fatigue resistance of endodontically treated teeth restored with three dowel-and-core systems.** *J Prosthet Dent 2005;93:45-50*

Purpose: The purpose of this study was to compare the load fatigue of 3 dowel and core systems. **Methods:** Fifteen endodontically treated maxillary central incisors were sectioned perpendicular to the long axis at a point 1.5mm incisal to the CEJ. At the level of the CEJ, specimens were then prepared for crowns with 1mm complete shoulder finish lines and 1.5mm of axial wall height. The prepared teeth were divided into three groups (n=5) and restored with one of of the following dowel and core combinations: Group CG, cast gold dowels and cores, Group TA, Titanium Alloy dowels (ParaPost XH) with composite cores, or Group FR, fiber-reinforced resin dowels (ParaPost FiberWhite) with composite cores. A dentin bonding agent (Optibond Solo) was placed prior to the composite cores. Dowel and core castings and Titanium alloy dowels were cemented with zinc phosphate cement. The fiber-reinforced dowels were cemented with a resin cement (ParaPost Cement). The crowns for all specimens were cast with an incisal notch for applying the fatigue load. The independent variable was the number of load fatigue cycles required to cause luting cement failure. The data were subjected to 1-way analysis of variance and the Student-Newman-Keuls test for 3 subsets (a=.05). **Results:** The mean value +/- standard deviation for the cycles to failure for each group was Group CG: 11,897 +/- 4080 load cycles, Group TA: 24,384 +/- 8231 load cycles, and Group FR: 50,696 +/- 7063 load cycles. Significant differences were found between all groups ($P<.05$). **Conclusions:** Fiber-reinforced dowels and bonded composite cores under fatigue loading provided significantly stronger crown retention than cast gold dowels and Titanium Alloy dowels with composite cores. **PDF**

Hader, S., Wiedig, C.A., Lachermeier, B., Peez, R. **Adhesion of various adhesive resin cements to fiber post.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 1856, 2009. (www.dentalresearch.org)*

Objectives: The purpose of this in vitro investigation was to evaluate the bond strength of self adhesive and adhesive resin cements to RelyX™ Fiber Post, a new glass fiber reinforced composite post (RLXFP, 3M ESPE). **Methods:** RelyX™ Unicem Aplicap™ self adhesive universal resin cement, (RXU, 3M ESPE), BisCem® (BIS, Bisco), G-CEM Capsule (GCM, GC), Maxcem™ (MC, Kerr) as well as Variolink® II (VAR) and Multilink® Automix (MUL, both from ivoclar vivadent) were used in combination with RLXFP (size 3). Except for MUL and VAR the fiberpost was not pre-treated. In case of MUL and VAR Monobond-S (MON, ivoclar vivadent) was used to silanize the post surface. Cements were light-cured (LC) or dark-cured (DC). Adhesion was tested on the conical part of the fiberposts and measured in a pull-off setup using an universal testing machine (Zwick Z010, crosshead speed 1mm/min). Data obtained from the different groups were analyzed using ANOVA. **Results:** The following table summarizes the mean adhesion values. **Conclusions:** RXU self adhesive universal resin cement showed best performance in both curing modes without any surface pre-treatment, whereas MON&MUL showed significantly lower bond strength when the dark cure mode was used. MC was found to have significantly lower bond strength in both curing modes.

Hayashi, M, Okamura, K, Wu H, Takahashi, Y, Koytchev, EV, Imazato, S, Ebisu, S. **The root canal bonding of chemical-cured total-etch resin cements.** *J Endod. 2008 May;34(5):583-6. Epub 2008 Mar 24.*

Discovering a durable restorative method to reconstruct and reinforce pulpless teeth is a vital key to help prevent root fractures. Complete and firm adhesion of resin cement in root canal dentin using a post is critical to achieve it. The null hypothesis in the present study was that the bond strength of dual-cured and chemical-cured adhesive resin cements to root canal dentin is not affected by their vertical locations in the root canal. In the experiments, extracted human incisors restored with fiber-reinforced posts and adhesive resin cements were subjected to microtensile bond strength testing. Then, the failure modes and the dentin-bonding interfaces were observed. Self-etch and self-adhesive dual-cured resin cements showed frequent pretesting failure despite using a silane coupling agent. Chemical-cured total-etch adhesive material showed stable bonding performances throughout the entire post space and thus has an advantage in post-core restorations.

Hedlund, S-O, Johanson, N. G., Sjogren, G. **Retention of prefabricated and individually cast posts in vitro**. *British Dental Journal Vol 195, No. 3. Aug 9, 2003 155-158.*

Objectives: The aim of the study was to evaluate the retention of prefabricated root canal posts made of a variety of materials that have recently been introduced to dentistry. **Methods**: The posts studied were Cosmopost (ceramic), Composipost / C-Post (Carbon fibres), Aestheti-Plus post (Quartz Fibres), Light-Post (Quartz fibres) and ParaPost White (glass fibres). The posts were luted in extracted human pre-molars and the cores were built up with the resin composites recommended by the (post) manufacturers. The retention of individually cast gold alloy posts luted with zinc phosphate cement were used as reference. A universal testing machine was used to determine the retention of each cemented post. Data were compared using ANOVA supplemented with Fisher's PLSD at a significance level of $p<0.05$. **Results:** Only the Cosmopost system exhibited retention values that were significantly lower than for the conventional cast gold alloy posts luted with zinc phosphate cement. The force necessary to loosen the Cosmopost specimens was significantly less than that needed to loosen the Aestheti-Plus post ($p<0.05$) and the Light-Post systems ($p<0.01$). The force necessary to loosen the ParaPost White specimens was significantly less than for the Light-Post system ($p<0.01$). Other combinations did not differ significantly ($p<0.05$). **PDF**

Heshmati, R., Nusstein, J.M., Rashid, R. **Retention of five prefabricated posts systems and gold cast post.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2175, 2010 (www.dentalresearch.org)*

Objective: The purpose of this in Vitro study was to compare the adhesion of five prefabricated post systems and gold cast post. **Methods:** Sixty extracted human, single-rooted, de-coronated maxillary central incisors were divided into 6 groups of ten. Canals were prepared utilizing ProFileTM .04 taper nickel-titanium rotary files (Dentsply, USA) and obturation was done utilizing gutta percha and Roth's 801 sealer (Roth Drug Co., Chicago, IL). Post space was immediately prepared to a length of 9 mm. Posts (Para Post XT, Coltene, USA, Spirapost standard and Taper, AMG America, USA, DentFlex Fiber, Brasseler USA, Carbon Post, Brasseler, USA and gold cast post, Heraeus, USA) were luted using RelyX™ cement following manufacturer's instruction. Teeth were mounted and loaded in testing machine (Instron® testing machine, Canton, Massachusetts, USA). Collected data were analyzed using ANOVA with a Tukey HSD post hoc test. **Results:** There was a statistical significantly difference between the mean retention strengths of C-post and the other five post systems ($p<0.0001$). There were no statistically significant differences in retention strengths between Para post, both Spiraposts, Fiber posts, and gold cast post ($p>0.05$). **Conclusion:** The high retention value of carbon post with resin cement were also reported on other in vitro studies.

Huber, L, Cattani-Lorente, M, Shaw, L, Krejci, I, Bouillaguet, S. **Push-out bond strengths of endodontic posts bonded with different resin-based luting cements.** *Am J Dent. 2007 Jun;20(3):167-72.*

Purpose: To compare the push-out bond strengths of endodontic posts bonded with different resin-based luting cements and to verify that bond strengths did not vary with cement thickness. **Methods:** 48 root canals were shaped using 6% NiTi rotary files, obturated with gutta-percha and AH Plus sealer and prepared for post cementation using Panavia F, Parapost cement, SuperBond and Unicem Rely X. All roots were sectioned into 0.7 mm thick slices and digital photographs of each slice were analyzed using Scion Image to measure the surface area of the luting cement. The root slices were stressed to failure at 1 mm/minute using a push-out test. Push-out strength was calculated as the force at failure divided by the bonded surface area. Least squares linear regression analysis was used to assess the effect of cement thickness on bond strength. Fractured specimens were further observed under the SEM. **Results:** Mean push-out bond strengths were: Panavia F (8.8 +/- 3.6 MPa), Parapost cement (9.1 +/- 4.4 MPa) SuperBond (14.6 +/- 2.9 MPa) and Rely X Unicem (12.4 +/- 3.3 MPa). The Panavia F and the Parapost cement were not significantly different from each other, but both were significantly lower ($P < \text{or} = 0.05$) than SuperBond and Rely X Unicem. **Conclusions:** Although there were large variations in cement thickness, the cementation of fiber posts with thicker cement layers did not affect the performance of the adhesive luting cements applied to root canal dentin.

Izadi, A, Azarsina, M, Kasraei, S. **Effect of eugenol-containing sealer and post diameter on the retention of fiber reinforced composite posts.** *J Conserv Dent. 2013 Jan;16(1):61-4. doi: 10.4103/0972-0707.105301*

Fiber reinforced composite (FRC) posts are cemented with resin cements. It is reported that using resin cements in canals sealed with eugenol-containing sealers reduces the post retention. However, there is controversy on the subject. Aims: **The aim was to investigate the influence of eugenol-containing sealers and the amount of dentin removal from root** canal with different post diameters on retention of FRC posts**. Settings and design**: It was an in vitro study. **Methods:** The roots of sixty teeth were cut with 14 mm distance from the apex and were instrumented to the working-length of 13 mm. The teeth were randomly distributed into 2 groups (n = 30). Following storage in normal saline for 7 days, the samples in both the groups were further divided into 3 subgroups (n = 10). Canals in the experimental subgroups (I, II, III) were obturated by gutta-percha and eugenol-containing sealer; and in the control subgroups (IV, V, VI) without any sealer. After storage in normal saline for 7 days, the post space was prepared by #3, #2, and #1 drills of DT Light-Post system. Post was cemented with Panavia-F2.0 resin-cement. A composite core was built for each sample. All samples were thermo cycled for 1000 cycles. The samples were tested for post retention with a mechanical testing machine. STATISTICAL ANALYSIS: Data were analyzed by two-way ANOVA and Tukey-HSD test. Results: There was not a significant difference in retention between FRC posts #1 and #2 ($P > 0.05$). Post #3 was more retentive than posts #1and #2 ($P < 0.05$). ZOE sealer significantly reduced the retention of posts ($P = 0.024$), however, increasing post-space diameter significantly increased post retention in canals coated with ZOE sealer ($P = 0.002$). **Conclusions:** Eugenol-containing sealer reduced the retention of FRC posts cemented with resin cement. Removing more dentin from root-canals treated with eugenol-containing sealer for placing larger diameter posts caused an increase in post retention.

*Kadam, A, Pujar, M, Patil, C. **Evaluation of push-out bond strength of two fiber-reinforced composite posts systems using two luting cements in vitro.** J Conserv Dent. 2013 Sep;16(5):444-8. doi: 10.4103/0972-0707.117522

Introduction: The concept of using a "post" for the restoration of teeth has been practiced to restore the endodontically treated tooth. Metallic posts have been commonly used, but their delirious effects have led to the development of fiber-reinforced materials that have overcome the limitations of metallic posts. The use of glass and quartz fibers was proposed as an alternative to the dark color of carbon fiber posts as far as esthetics was concerned. "De-bonding" is the most common failure in fiber-reinforced composite type of posts. This study was aimed to compare the push-out bond strength of a self-adhesive dual-cured luting agent (RelyX U100) with a total etch resin luting agent (Variolink II) used to cement two different FRC posts. **Methods:** Eighty human maxillary anterior single-rooted teeth were de-coronated, endodontically treated, post space prepared and divided into four groups (n = 20); Group I: D.T. light post (RTD) and Variolink II (Ivoclare vivadent), Group II: D.T. light post (RTD, St Egreve, France) and RelyX U100 (3M ESPE), Group III: Glassix post (Nordin) and Variolink II (Ivoclar vivadent) and Group IV: Glassix post (Nordin) and RelyX U100 (3M ESPE). Each root was sectioned to get slices of 2 ± 0.05-mm thickness. Push-out tests were performed using a triaxial loading frame. To express bond strength in megapascals (Mpa), load value recorded in Newton (N) was divided by the area of the bonded interface. After testing the push-out strengths, the samples were analyzed under a stereomicroscope. **Results:** The mean values of the push-out bond strength show that Group I and Group III had significantly higher values than Group II and Group IV. The most common mode of failure observed was adhesive between dentin and luting material and between post and luting material. **Conclusions:** The mean push-out bond strengths were higher for Groups I and III where Variolink II resin cement was used for luting the fiber post, which is based on the total etch adhesive approach. In most of the samples, failure was observed between cement-dentine interface, followed by post-cement interface, which shows difficulty in bonding between post-cement-dentine interface. **PDF**

*Khamverdi, Z, Damavandi, LY, Kasraei, S. **Effect of cyclic loading on bond strength of fiber posts to root canal dentin.** J Dent (Tehran). 2014 Jan;11(1):85-92. Epub 2014 Jan 31.

Objective: The aim of this study was to evaluate the effect of cyclic loading on the bond strength of quartz fiber posts to root canal dentin after different surface treatments of different regions of root canal dentin. **Methods:** Forty-eight single-rooted human teeth were selected. Post spaces were prepared and then the teeth were divided into four groups: G1: no treatment (control); G2: irrigation with a chemical solvent; G3: etching with 37% phosphoric acid; G4: treatment with ultrasonic file. The fiber posts (DT Light-Post) were cemented using dual-cured resin cement. Half of the specimens were load-cycled (10000 cycles, 3 cycles/s) and the others did not undergo any load cycling. From each root, two slides measuring 1 mm in thickness were obtained from the apical and cervical regions. The push-out bond strength test was performed for each slice. Data were analyzed by using 3-way ANOVA and Tukey HSD tests. The fracture modes were evaluated under a stereomicroscope at ×20. **Results:** The effect of load cycling and surface treatment as the main factors and the interaction of main factors were not significant (P=0.734, P=0.180, and P=0.539, respectively). The most frequent failure mode under the stereomicroscope was adhesive. **Conclusion:** It appears that load cycling and surface treatment methods had no effect on the bond strength of fiber posts to root canal dentin, but it depended on the region of the root canal dentin. **PDF**

Krause, F., Bahr, P., Jepsen, S., Braun, A. **Bonding of glass-fiber posts to root canal dentin in vitro**. *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 3194, 2009. (www.dentalresearch.org)*

Objectives: The aim of this study was to determine bonding properties of different cements and dentin adhesive systems for glass-fiber posts. **Methods:** 45 freshly extracted human teeth were endodontically treated. Glass-fiber posts were cemented using three different methods: dual-cured composite (Multilink™) with conditioning of dentin (I), composite-reinforced glass ionomer cement (Meron™) without conditioning of dentin (II) and dual-cured composite (Rebilda™) with conditioning of dentin (III). After thermocycling, the end of the post was exposed by cutting the root 5 mm to the end at the level gutta-percha/ glass-fiber post. For REM analysis, impressions of the exposed root surfaces were taken and replicas were produced. Teeth were cleared using nitric acid (5%), alcohol (80%, 90%, 100%) and methyl-salicylate. Subsequently, an ink penetration procedure was performed to assess leakage between the glass-fiber post and root dentine by measuring the depth of dye penetration. **Results:** In goup II, a statistically significant deeper dye penetration (median: 1.02 [mm], min: 0, max: 1.02) could be observed compared to group III (median: 0.36 [mm], min: 0, max: 1.52) ($p<0.05$) with no difference between group I (median: 0.57 [mm], min: 0, max: 2.66) and III ($p>0.05$). Regarding apical leakage after REM analysis, no differences between the groups became evident ($p>0.05$). **Conclusion:** In endodontically treated teeth, glass-fiber posts should be inserted preferably with a dual-cure composite after conditioning the root dentin. In this study, the evaluated dual-cure composites in combination with the respective dentin adhesive system were not different with respect to apical leakage.

*Kremeier, K, Fasen, L, Klaiber, B, Hofmann, N. **Influence of endodontic post type (glass fiber, quartz fiber or gold) and luting material on push-out bond strength to dentin in vitro.** *Dent Mater. 2008 May;24(5):660-6. Epub 2007 Aug 23.*

Objectives: To determine the influence of post type and luting material on bond strength to dentin. **Methods:** The root canals of extracted human upper central incisors were instrumented and post space was prepared using the respective drills for each post system. Glass fiber posts (Luscent Anchor, Dentatus [LA]) were luted using three dual-curing adhesive systems (Excite DSC/Variolink II, Vivadent [VL2]; EnaBond/EnaCem, Micerium [ENA]; Prime & Bond NT/Calibra, DentSply DeTrey [CAL]). A different brand of glass fiber post (EasyPost, DentSply Maillefer [EP]) and quartz fiber post (DT Light- Post, VDW/ RTD, St Egreve, France [DT]) were luted using CAL. Gold posts (Perma-dor, VDW) were luted either adhesively following tribo-chemical silicate coating (Rocatec, ESPE-Sil, 3M ESPE; CAL) or conventionally using glass ionomer cement (Ketac Cem, 3M ESPE). Three slices of 2mm height were cut perpendicular to the post from each restored root. Bond strength was determined by pushing out the post using a universal testing machine (/1449, Zwick**). Results:** For all experimental groups combined, bond strength increased from the coronal to the apical section (Friedman test: $P<0.001$). Significant differences were observed among the fiber posts (DT/CAL>LA/CAL; Mann-Whitney U-test with Bonferroni-Holm adjustment: $P<0.05$; EP/CAL ranging in between) but not among luting materials (LA/VL2, LA/ENA, LA/CAL: n.s.). The gold posts were equivalent to DT/CAL with both luting procedures. **Significance:** Selection of post type may be more important for bond strength than luting material. Bond strength of fiber posts was equivalent but not superior to adhesively or conventionally luted gold posts. **PDF**

Lombardo, G., Souza, R., Michida, S., deMelo, R., Bottino, M A. Valandro, L. **Resin bonding to root canal dentin: Effect of the application of an experimental hydrophobic coating after an all-in-one adhesive.** *Journal of Contemporary Dental Practice Vol. 9, No. 4, May 1 , 2008.*

Aim: Based on the hypothesis the application of a low-viscosity hydrophobic resin coating improves the bond of all-in-one adhesive, the purpose of the study was to evaluate the bond strength of four adhesive systems to bovine root dentin using the push-out test method. **Methods:** The root canals of 32 bovine roots (16 mm) were prepared to a length of 12 mm using a FRC Postec Plus preparation drill. The specimens were allocated into four groups according to the adhesive system used: (Group 1) All-in-one Xeno III; (Group 2) All-in-one Xeno III+ScotchBond Multi-Purpose Plus Adhesive; (Group 3) Simplified Etch & Rinse One Step Plus; and (Group 4) Multi-Bottle Etch & Rinse All-Bond 2. A fiber-reinforced composite retention post was reproduced using an additional silicon impression and fabricated with DuoLink resin cement. The root specimens were treated with the selected adhesive systems, and the resin posts were luted in the canals with DuoLink resin cement. Each root specimen was cross sectioned into

four samples (+/-1.8 mm in thickness), and the post sections were pushed-out to determine the bond strength to dentin. **Results:** Group 2 (2.9+/-1.2) was statistically higher than Group 1 (1.1+/-0.5) and Group 3 (1.1+/-0.5). Groups 1 and 3 showed no statistically significant difference while Group 4 (2.0+/-0.7) presented similar values (p>0.05) to Groups 1, 2, and 3 [(one-way analysis of variance (ANOVA)] and Tukey test, a=0.05). **Conclusion:** The hypothesis was accepted since the application of the additional layer of a low-viscosity bonding resin improved the bond of the all-in-one adhesive. Further studies must be conducted to evaluate the long-term bond. **PDF**

Macedo, VC, Faria, e Silva AL, Martins, LR. **Effect of cement type, relining procedure, and length of cementation on pull-out bond strength of fiber posts.** *J Endod. 2010 Sep;36(9):1543-6. Epub 2010 Jul 6.*

Introduction: As opposed to the cementation metal posts, the cementation of fiber posts has several details that can significantly influence the success of post retention. This study evaluated the effect of the relining procedure, the cement type, and the luted length of the post on fiber posts retention. **Methods:** One hundred eighty bovine incisors were selected to assess post retention; after endodontic treatment, the canals were flared with diamonds burs. Post holes were prepared in lengths of 5, 7.5, and 10 mm; the fiber posts were relined with composite resin and luted with RelyX ARC, RelyX Unicem, or RelyX Luting 2. All cements are manufactured by 3M ESPE (St. Paul, MN). Samples were subjected to a pull-out bond strength test in a universal testing machine; the results (N) were submitted to a three-way analysis of variance and the Tukey post hoc test (alpha = 0.05). **Results:** The improvement of post retention occurred with the increase of the post length luted into the root canal; the relining procedure improved the pull-out bond strength. RelyX Unicem and RelyX ARC showed similar values of retention, both showing higher values than RelyX Luting 2. **Conclusion**: Post length, the relining procedure, and the cement type are all important factors for improving the retention of fiber posts.

*Mallmann, A, Jacques, LB, Valandro, LF, Mathias, P, Muench, A. **Microtensile bond strength of light- and self-cured adhesive systems to intraradicular dentin using a translucent fiber post.** *Oper Dent. 2005 Jul-Aug;30(4):500-6*

This study evaluated the bond strength of a light- and self-cured adhesive system to different intra-radicular dentin areas (cervical, middle and apical thirds). Twenty single-rooted teeth were instrumented and their roots were prepared to receive a #2 translucent fiber post (Light Post). The root canals were irrigated with 0.5% sodium hypochlorite for one minute, rinsed with water and dried using paper tips. The teeth were divided into two groups (n=10): Single Bond [SB] (light-cured) and Scotchbond Multi-Purpose Plus [SBMP] (self-cured). To avoid polymerization of the materials through the root lateral walls, the teeth were placed in a silicone mold and the adhesives applied with a thin microbrush according to manufacturer's instructions. The resin cement, Rely X ARC, was inserted into the root canals using Lentulo burs. The post was then placed and the light-curing procedure was carried out for 40 seconds (+/-500 mW/cm2). The roots were kept in a 100% relative moisture environment for 24 hours and stored in distilled water for an additional 24 hours. Each root was perpendicularly sectioned into 1-mm thick sections, resulting in approximately four slices per region. Dumbbell-shaped slices were obtained by trimming the proximal surfaces of each slice using a diamond bur until it touched the post. The bonded area was calculated, slices were attached to a special device and submitted to micro-tensile testing at 1 mm/minute crosshead speed. Data were analyzed using ANOVA and Tukey's test. The mean bond strength values (MPa) were: SBMP: cervical=10.8a, middle=7.9b%, apical=7.1bc; SB: cervical=8.1b, middle=6.0c, apical=6.9b. Significant differences were found between adhesive systems only for the cervical third. The cervical region showed higher mean bond strength values than the middle and apical regions (p<0.0001). **PDF**

Mallmann, A, Jacques, LB, Valandro, LF, Muench, A**. Microtensile bond strength of photoactivated and autopolymerized adhesive systems to root dentin using translucent and opaque fiber-reinforced composite posts**. *J Prosthet Dent. 2007 Mar;97(3):165-72*

Statement of Problem: The use of fiber-reinforced composite resin posts in endodontically treated teeth has increased. However, selecting an adhesive system that provides reliable and long-lasting bonding to root canal dentin remains difficult. **Purpose:** This study evaluated the microtensile bond strength of 2 adhesive systems to root dentin and 2 different fiber-reinforced composite resin posts. **Methods:** Forty single-rooted teeth were instrumented, and root canals were prepared for translucent (Light Post [LP]) or opaque (Aestheti Post [AP]) quartz fiber-reinforced composite resin posts. Two adhesive systems were used: Scotchbond Multi-Purpose Plus (SBMP) (autopolymerized) as a control group, and Single Bond (SB) (photoactivated). Teeth were assigned to 4 groups (n=10): SBMP+LP, SBMP+AP, SB+LP, SB+AP. After post cementation, roots were perpendicularly sectioned into 1-mm-thick slices, which were trimmed to obtain dumbbell-shaped specimens. The specimens were divided into 3 regions: cervical (C), middle (M), and apical (A). To determine the bond strength, the bonding area of each specimen was calculated, and specimens were attached to a device to test microtensile strength at a crosshead speed of 1 mm/min. Data were analyzed using 3-way analysis of variance and the Tukey test (alpha=.05). Fractured specimens were examined under a x 25 stereomicroscope to determine the mode of fracture. **Results:** There were significant differences only among root dentin regions (P<.001). The cervical third (9.16 +/- 1.18 MPa) presented higher mean bond strength values, especially for SBMP. Middle and apical regions demonstrated lower values (7.08 +/- 0.92 and 7.31 +/- 0.60 MPa, respectively). Adhesive and post main factors did not demonstrate significance. Also, no interaction was significant. No cohesive fractures within resin cement, fiber-reinforced composite resin post, or root dentin were identified. **Conclusions:** Both adhesive systems tested demonstrated reliable bonding when used with translucent and opaque fiber-reinforced composite posts. **PDF**

Manicardi, CA, Versiani, MA, Saquy, PC, Pécora, JD, de Sousa-Neto, MD. **Influence of filling materials on the bonding interface of thin-walled roots reinforced with resin and quartz fiber posts**. *J Endod. 2011 Apr;37(4):531-7.*

Introduction: A common complication during the restoration of severely destroyed teeth is the loss of coronal root dentine. The aim of this study was to evaluate the influence of different sealers on the bonding interface of weakened roots reinforced with resin and fiber posts. **Methods:** Sixty extracted maxillary canines were used. The crowns were removed, and the thickness of root dentine was reduced in the experimental (n = 40) and positive control (n = 10) groups. The specimens of experimental group were assigned to four subgroups (n = 10) according to the filling material: gutta-percha + Grossmann's sealer, gutta-percha + AH Plus (Dentsply De Trey Gmbh, Konstanz, Germany), gutta-percha + Epiphany (Pentron Clinical Technologies, Wallingford, CT), and Resilon (Resilon Research LLC, Madison, CT) + Epiphany. In the negative control group (n = 10), canals were not filled. After post space preparation, the roots were restored with composite resin light-activated through a translucent fiber post. After 24 hours, specimens were transversally sectioned into 1-mm-thick slices. Push-out test and scanning electron microscopic (SEM) analyses of different regions were performed. Data from push-out test were analyzed by using Tukey post hoc multiple comparison tests. The percentage of failure type was calculated. Data from SEM analysis were compared by Friedman and Kruskal-Wallis tests ($\alpha = 0.05$). **Results:** The mean bond strength was significantly higher in the negative control group as compared with the other groups ($P < .05$). In all groups, the most frequent type of failure was adhesive. Overall, apical and middle regions presented a lower density of resin tags than the coronal region ($P < .05$). **Conclusions:** The push-out bond strength was not affected by sealer or region. The canal region affected significantly the resin tag morphology and density at the bonding interface.

Marcos, RM, Kinder, GR, Alfredo, E, Quaranta, T, Correr, GM, Cunha, LF, Gonzaga, CC. **influence of the resin cement thickness on the push-out bond strength of glass fiber posts.** *Braz Dent J. 2016 Sep-Oct;27(5):592-598. doi: 10.1590/0103-6440201600886.*

The objective of the present study was to evaluate the influence of resin cement thickness on the bond strength of prefabricated and customized glass fiber posts after storage in distilled water. Thirty human uniradicular roots were treated endodontically. The roots were divided into 3 groups: THIN (thin cement layer) - post space preparation with #0.5 drill and cementation of #0.5 post; THICK (thick cement layer) - post space preparation with #1 drill and cementation of #0.5 post; and CUSTOM (customized cement layer) - post space preparation with #1 drill and cementation of a customized post (#0.5 glass fiber posts customized with resin composite). All posts were luted with self-adhesive resin cement. The push-out test was carried out after storage for 24 h and 90 days in distilled water at 37 °C. The data were analyzed with three-way ANOVA and Tukey's test (a=0.05). Bond strengths were significantly higher for CUSTOM (9.37 MPa), than for THIN (7.85 MPa) and THICK (7.07 MPa), which were statistically similar. Considering the thirds, the bond strength varied in the sequence: apical (7.13 MPa) < middle (8.22 MPa) = coronal (8.94 MPa). Bond strength for 24 h storage was significantly higher (8.80 MPa) than for 90-day storage (7.40 MPa). It may be concluded that the thickness of resin cement influenced the bond strength of glass fiber posts. The customized posts presented higher bond strength. Storage in water for 90 days affected negatively the values of bond strength, especially for thick cement layers in the apical third.

*Mazzoni, A., Marchesi, G., Cadenaro, M., Mazzotti, G., Di Lenarda, R., Ferrari, M., Breschi, L. **Push-out stress for fibre posts luted using different adhesive strategies**. *Eur J Oral Sci. 2009 Aug;117(4):447-53.*

The influence of thermocycling on the bond strength of fibre posts cemented with different luting approaches was investigated. A total of 84 human incisors were selected for the study. Sixty teeth were assigned to one of the following adhesive/cement combinations for push-out bond-strength evaluation: group 1, XP Bond/CoreXFlow + DT Light-Post; group 2, Panavia F 2.0 + Tech 21; or group 3, RelyX Unicem + RelyX. Bonded specimens were cut into 1-mm-thick slabs and either thermocycled (40,000 cycles) or stored in artificial saliva (control specimens) before push-out bond-strength testing. Additional specimens were processed for quantitative interfacial nanoleakage analysis. Thermocycling decreased the bond strength in specimens of groups 2 and 3, but did not affect the specimens from group 1. No difference was observed among luting approaches in control specimens. Thermocycling resulted in increased silver nitrate deposition (i.e. interfacial nanoleakage) in all groups. Within the limitations of the study, the use of an etch-and-rinse adhesive in combination with a dual-cure cement to lute fiber posts is the most stable luting procedure if compared with a self-etch resin-based cement or a self-adhesive cement, as assayed by thermocycling of the bonded specimens.
PDF

Melo, RM, Ozcan, M, Barbosa, SH, Galhano, G, Amara,l R, Bottino, MA, Valandro, LF. **Bond strength of two resin cements on dentin using different cementation strategies.** *J Esthet Restor Dent. 2010 Aug;22(4):262-8.*

Purpose: This study evaluated the micro-tensile bond strength of two resin cements to dentin either with their corresponding self-etching adhesives or employing the three-step "etch-and-rinse" technique. The null hypothesis was that the "etch-and-rinse" adhesive system would generate higher-bond strengths than the self-etching adhesives. **Methods:** Thirty-two human molars were randomly divided into four groups (N = 32, n = 8/per group): G1) ED Primer self-etching adhesive + Panavia F; G2) All-Bond 2 "etch-and-rinse" adhesive + Panavia F; G3) Multilink primer A/B self-etching adhesive + Multilink resin cement; G4) All-Bond 2 + Multilink. After cementation of composite resin blocks (5 x 5 x 4 mm), the specimens were stored in water (37 degrees C, 24 hours), and sectioned to obtain beams (+/-1 mm(2) of adhesive area) to be submitted to micro-tensile test. The data were analyzed using 2-way analysis of variance and Tukey's test (alpha = 0.05). **Results:** Although the cement type did not significantly affect

the results (p = 0.35), a significant effect of the adhesive system (p = 0.0001) was found on the bond strength results. Interaction terms were not significant (p = 0.88751). The "etch-and-rinse" adhesive provided significantly higher-bond strength values (MPa) with both resin cements (G2: 34.4 +/- 10.6; G4: 33.0 +/- 8.9) compared to the self-etching adhesive systems (G1: 19.8 +/- 6.6; G3: 17.8 +/- 7.2) (p < 0.0001). Pretest failures were more frequent in the groups where self-etching systems were used. **Conclusions:** Although the cement type did not affect the results, there was a significant effect of changing the bonding strategy. The use of the three-step "etch-and-rinse" adhesive resulted in significantly higher bond strength for both resin cements on dentin. **Clinical Significance:** dual polymerized resin cements tested could deliver higher bond strength to dentin in combination with "etch-and-rinse" adhesive systems as opposed to their use in combination with self-etching adhesives.

Michida, SMA, Souza, ROA, Passos, SP, Mesquita, AMM. Pereira, PC, Valandro, LF, Takahashi, FE, Bottino MA. **Influence of cement insertion technique on fiber post bond strength**, *J Dent Res.Vol 87 (Spec Iss A) Abstract #1745, 2008 (www.dentalresearch.org)*

Objective: this study evaluated the influence of different methods of resin cement insertion on the bond strength between bovine root dentine and fiber posts (null hypothesis: the insertion methods do not influence the bond strength). **Methods:** forty bovine roots (16mm) (single-root) were prepared to 12 mm with custom drill of the fiber post system (FRC Postec Plus). The roots were embedded in chemically cured acrylic resin using a surveyor. The specimens were divided into 4 groups, according to the methods of resin cement insertion: G1- Lentulo drill, G2- Centrix syringe, G3- Explorer #5, G4- with the aid of the post. The root canals were rinsed with 20 mL of distilled water, and dried with paper points. The root dentine was etched with H2PO3 37%/15s + washing/drying and the adhesive system All-Bond 2 was applied, and right away the cylinder quartz fiber posts (Aestheti-Plus) were cemented (RelyX). The samples were kept in distilled water 37^0 C for 24 h, then, each specimen was cut into 4 slices of ±1.8 mm of thickness, and the samples were submitted to push-out test (Emic DL-1000) (1mm/min). **Results:** ANOVA (a=0.05) showed that the bond strength (MPa) was not affected by resin cement insertion methods (P>0.05). G1 (4.21±1.27a), G2 (3.17±1.79a), G3 (4.46±0.95a), G4 (3.12±1.28a), (null hypothesis was accepted). **Conclusion:** the resin bond strength between the bovine root dentin and the fiber posts are not influenced by the resin cement insertion methods.

*Mazzitelli, C, Ferrari, M, Toledano, M, Osorio, E, Monticelli, F, Osorio, R. **Surface roughness analysis of fiber post conditioning processes.** *J Dent Res. 2008 Feb;87(2):186-90.*

The chemo-mechanical surface treatment of fiber posts increases their bonding properties. The combined use of atomic force and confocal microscopy allows for the assessment and quantification of the changes on surface roughness that justify this behavior. Quartz fiber posts were conditioned with different chemicals, as well as by sandblasting, and by an industrial silicate/silane coating. We analyzed post surfaces by atomic force microscopy, recording average roughness (R(a)) measurements of fibers and resin matrix. A confocal image profiler allowed for the quantitative assessment of the average superficial roughness (R(a)). Hydrofluoric acid, potassium permanganate, sodium ethoxide, and sandblasting increased post surface roughness. Modifications of the epoxy resin matrix occurred after the surface pre-treatments. Hydrofluoric acid affected the superficial texture of quartz fibers. Surface-conditioning procedures that selectively react with the epoxy-resin matrix of the fiber post enhance roughness and improve the surface area available for adhesion by creating micro-retentive spaces without affecting the post's inner structure.

*Monticelli, F, Osorio, R, Tay, FR, Sadek, FT, Ferrari, M, Toledano M. **Resistance to thermo-mechanical stress of different coupling agents used as intermediate layer in resin-fiber post bonds.** *Am J Dent. 2007 Dec;20(6):416-20.*

Purpose: To evaluate the microtensile bond strength (MTBS) of different coupling agents used in fiber post-composite bonds to withstand different in vitro challenging procedures. **Methods:** 63 fiber posts (D.T. Light-Post: RTD, St Egreve, France) etched with 10% hydrogen peroxide were divided into three groups according to the silane/adhesive system applied: (1) Porcelain Bond Activator (PBA) + Clearfil SE Bond; (2) PBA + Clearfil Tri S Bond; (3) Monobond-S. A composite build-up (Clearfil AP-X) was performed around the post producing cylindrical specimens that were divided into three subgroups according to the different aging protocol: (1) 24-hour storage at room temperature; (2) Thermocycling (5000 cycles, 5 degrees/55 degrees C dwell time: 30 seconds); (3) Cyclic loading (45 degrees angle, 20,000 cycles, load 5-50 N at 3.0 Hz). Samples were then cut obtaining sticks that were loaded in tension until failure. Bond strength values were statistically analyzed with two-way ANOVA and Tukey test (alpha = 0.05). Failure mode was recorded and the morphologic aspect of post/core interface after aging was evaluated under SEM. **Results:** Both post superficial treatment, thermocycling and cyclic loading influenced bond strength. After 24 hours, samples treated with silane/adhesive couplings attained higher MTBS than those bonded with conventional silane. No significant differences in the microtensile bond strength at the post/core interface were recorded between the different silane/adhesive couplings. After challenging, no differences were found between the tested groups.

Naumann, M, Sterzenbach, G, Rosentritt, M, Beuer, F, Frankenberger, R. **Is adhesive cementation of endodontic posts necessary?** *J Endod. 2008 Aug;34(8):1006-10.*

Recently, the appropriate, durable bond of adhesive systems and composite resin cements to retain endodontic posts was challenged. The question arises whether it would be possible to place glass fiber posts in a less technique sensitive conventional nonadhesive approach. The influence of nonadhesive, self-adhesive, and etch-and-rinse systems on load capability of postendodontic restorations was studied. Human maxillary central incisors were divided into 4 groups (n = 10). Teeth were endodontically treated and restored by using glass fiber posts luted with different cements/composite resin combinations: (1) RelyX Unicem (3M ESPE

Seefeld, Germany)/Clearfil Core (Kuraray Europe, Duesseldorf, Germany), (2) RelyX Unicem/LuxaCore, (3) zinc phosphate cement/Clearfil, and (4) LuxaCore (DMG, Hamburg, Germany)/Clearfil. A 2 mm-ferrule preparation was performed. All specimens received adhesively luted all-ceramic crowns and were exposed to thermal cycling and mechanical loading before subsequent static loading. Significant differences between the experimental groups regarding load capability and fracture patterns were observed. The conventional non-adhesive post cementation is less reliable to withstand simulated functional forces compared to adhesive approaches. **PDF**

*Perdigão J, Gomes G, Augusto V. **The effect of dowel space on the bond strengths of fiber posts**. *J Prosthodont. 2007 May-Jun;16(3):154-64*

Purpose: The purpose of this study was to evaluate the effect of the degree of mismatch between post space and post diameters on the bond strength of a fiber-reinforced resin post. **Methods:** Thirty-two extracted human maxillary central incisors and canines were endodontically treated and assigned to four groups: Group 1--Canal prepared with a D.T. Light -Post #1 drill (control); Group 2--Canal prepared with a D.T. Light -Post #2 drill; Group 3--Canal prepared with a D.T. Light- Post #3 drill; Group 4--Canal prepared with a Gates Glidden #6 drill. A D.T. Light -Post size 1 was then luted into the canal using One-Step Adhesive and Post Cement Hi-X. A push-out test was performed on three sections of each root to measure push-out bond strengths. Data were analyzed with ANOVA and Bonferroni's test at $p < 0.05$. Two extra teeth for each group were restored in the same fashion and processed for SEM observation. **Results:** (in MPa): Group 1: 15.7 +/- 6.9; Group 2: 14.7 +/- 6.5; Group 3: 14.0 +/- 5.0; Group 4: 14.0 +/- 5.1. The variable "post space" resulted in no statistically significant difference in mean bond strengths ($p > 0.05$). For the variable "root region," the coronal third (17.5 +/- 6.0) resulted in statistically greater mean bond strengths than the apical third (12.3 +/- 6.0) at $p < 0.008$. The middle third (14.0 +/- 5.3) resulted in no statistically significant different mean bond strengths from the coronal third at $p > 0.119$ and from the apical third at $p > 0.999$. Under the SEM, some areas of the canal system still displayed residual gutta-percha, which resulted in debonding of the interface between the resin cement and dentin. Areas with incomplete dentin hybridization were observed in localized areas of all groups. **Conclusions:** The diameter of the post space did not affect the push-out bond strengths. Bonding at the coronal level of the root canal is more reliable than bonding at the apical level. The presence of residual gutta-percha and the deficient dentin hybridization may result in deficient seal of the resin-dentin interface. **PDF**

Perez, BE, Barbosa, SH, Melo, RM, Zamboni, SC, Ozcan, M, Valandro, LF, Bottino, MA. **Does the thickness of the resin cement affect the bond strength of a fiber post to the root dentin?** *Int J Prosthodont. 2006 Nov-Dec;19(6):606-9*

This study aimed to evaluate the influence of cement thickness on the bond strength of a fiber-reinforced composite (FRC) post system (Light-Post, RTD, St Egreve, France) to the root dentin. Eighteen single-rooted human teeth were decoronated (length: 16 mm), the canals were prepared, and the specimens were randomly allocated to 2 groups ($n = 9$): group 1 (low cement thickness), in which size 3 FRC posts were cemented using adhesive plus resin cement; and group 2 (high cement thickness), in which size 1 FRC posts were cemented as in group 1. Specimens were sectioned, producing 5 samples (thickness: 1.5 mm). For cement thickness evaluation, photographs of the samples were taken using an optical microscope, and the images were analyzed. Each sample was tested in push-out, and data were statistically analyzed. Bond strengths of groups 1 and 2 did not show significant differences ($P = .558$), but the cement thicknesses for these groups were significantly different ($P < .0001$). The increase in cement thickness did not significantly affect the bond strength ($r2 = 0.1389$, $P= .936$). Increased cement thickness surrounding the FRC post did not impair the bond strength. **PDF**

Pest, L. B., Cavalli, G., Bertani, P., Gagliani, M. **Adhesive post-endodontic restorations with fiber posts: push-out tests and SEM observations**. *Dental Materials 18 (2002) 596-602*

Objectives: Nowadays, the restoration of endodontically treated teeth is based on the use of materials with a modulus of elasticity similar to that of dentin (18.6 GPa). Fiber posts, resin cements and some composite resins all have this characteristic. This study evaluated the bond strength between luting materials, root dentin and fiber posts through push-out tests and examined the integration among these three components through scanning electron microscopy. **Methods**: Endodontically treated extracted teeth and plastic plates were used to test the interface between luting agent and dentin and dentin and luting agent and post. **Results:** Chemical affinity between different components (luting materials and fiber posts) is extremely important in achieving high bond strength. The bond strength tests and SEM observations showed that in-vitro, composite resins perform better than resin cements. **Conclusions:** Adhesive luting of posts is an alternative technique that is comparable and in some ways superior to the traditional technique that uses resin cements. Composite resins are easy to use and ergonomically advantageous because the same material can be used to lute the post and restore the core. Particular attention should be paid to the association between translucent posts and light-cured composite resins. This technique has the advantage of prolonged working time. Further investigation is needed to demonstrate the complete conversion of light-cured composite at different depths. **Significance:** The in vivo use of these materials may significantly reinforce residual tooth structure therefore reducing the risk for fracture and debonding. **PDF**

Phark, J-H., Welch, J., Dietschi, D., Sadan, A. **Push-out bond strength of parallel and tapered posts to dentin**. *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 973, 2009. (www.dentalresearch.org)*

Objective: to evaluate push-out bond-strength (PBS) of glass-fiber reinforced posts with two different designs using three different luting cements with and without following manufacturers' recommendations for cementing. **Methods:** 90 teeth were de-coronated, root canal treated, and divided into 15 groups. 11 mm long post-spaces were drilled into each tooth using a parallel drill for 45 samples and a tapered drill for the rest. Corresponding parallel (P; ParaPost Fiber Lux) and tapered (T; ParaPost Taper Lux) posts were cemented using two cement systems (Panavia F2.0 (PAN) and Paracore (PAR)) using their corresponding self-etching adhesives, and a self-adhesive cement, Unicem (UNI). In half of the samples cements were used according to manufacturers' recommendations (NE) in the other half dentin was etched (E) with phosphoric acid for 15 seconds before application of the adhesive. Control groups with parallel post spaces but without posts were filled with one of the three cements only. Two teeth of each group were subjected to 20,000 cycles of thermal-cycling (TC). All teeth were sectioned in 1 mm thick disks and a total of 593 disks were tested for PBS. Kruskal-Wallis tests were used with an adjusted α=0.002. **Conclusion:** In this study, artificial aging by TC and etching of the dentin before bonding reduced PBS significantly. Design of posts had no influence on PBS, which was also similar to control groups without posts. Paracore and Unicem achieved significantly higher PBS than Panavia F2.0.

Jatyr Pisani-Proença, Maria Carolina Guilherme Erhardt, Regina Amaral, Luiz Felipe Valandro, Marco Antonio Bottino, Ramón Del Castillo-Salmerón **Influence of different surface conditioning protocols on microtensile bond strength of self-adhesive resin cements to dentin.** *The Journal of Prosthetic Dentistry Volume 105, Issue 4, April 2011, Pages 227-235*

According to manufacturers, bonding with self-adhesive resin cements can be achieved without any pretreatment steps such as etching, priming, or bonding. However, the benefit of saving time with these simplified luting systems may be realized at the expense of compromising the bonding capacity. **Purpose:** The purpose of this study was to assess whether different dentin conditioning protocols influence the bond performance of self-adhesive resin cements to dentin. **Methods:** Flat dentin surfaces from 48 human molars were divided into 4 groups (n=12): 1) control, no conditioning; 2) H_3PO_4, etching with 37% H_3PO_4 for 15 seconds; 3) SEBond, bonding with self-etching primer adhesive (Clearfil SE Bond); and 4) EDTA, etching with 0.1M EDTA for 60 seconds. The specimens from each dentin pre-treatment were bonded using the self-adhesive cements RelyX Unicem, Maxcem or Multilink Sprint (n=4). The resin-cement-dentin specimens were stored in water at 37°C for 7 days, and serially sectioned to produce beam specimens of 1.0 mm^2 cross-sectional area. Microtensile bond strength (μTBS) testing was performed at 1.0 mm/min. Data (MPa) were analyzed by 2-way ANOVA and Tukey multiple comparisons test (α=.05). Fractured specimens were examined with a stereomicroscope (x40) and classified as adhesive, mixed, or cohesive. Additional bonded interfaces were evaluated under a scanning electron microscope (SEM).Results Cement-dentin μTBS was affected by the dentin conditioning approach (P<.001). RelyX Unicem attained statistically similar bond strengths to all pre-treated dentin surfaces. H_3PO_4-etching prior to the application of Maxcem resulted in bond strength values that were significantly higher than the other groups. The lowest μTBS were attained when luting Multilink Sprint per manufacturers' recommendations, while H_3PO_4-etching produced the highest values followed by Clearfil SE bonding and EDTA. SEM observations disclosed an enhanced potential of the self-adhesive cements to form a hybrid layer when applied following manufacturer's instructions. **Conclusions:** When evaluated self-adhesive resin cements are used, selectively etching dentin with H_3PO_4 prior to luting results in the most effective bonding.

*Potesta, F., Broome, J., O'neal, S., Givan, D., Ramp, L. **The effect of etching technique on the retention of adhesively cemented prefabricated dowels.** *J Prosthodont. 2008 Aug;17(6):445-50*

Purpose: To determine if etching technique influences the bond strength of resin cement to root canal dentin. **Methods:** Fifty-five extracted teeth were endodontically treated, dowel space prepared, and divided into five groups. Each group was treated with different etchant consistencies: acid gel, semi-gel, low-viscosity gel, liquid, and a self-etching primer. After dowel cementation, four sections were removed from each root and a push-out test was performed. **Results:** Significant effects were found for etching procedure and for location within the root canal. The apical segment produced the lowest bond strength. Self-etching primer showed the highest bond strength. **Conclusions**: The consistency of etchant material influenced the bond strength of a prefabricated dowel in the canal. **PDF**

Prisco, D., De Santis, R, Mollica, F., Ambrosio, L., Rengo, S., Nocolais, L. **Fiber post adhesion to resin luting cements in the restoration of endodontically - treated teeth**. *Operative Dentistry, 2003, 28-5, 515-521.*

Clinical Relevance: With respect to the adhesion properties of carbon fiber posts and glass fiber posts used in the restoration of endodontically - treated teeth, they perform equally well if used in combination with chemically cured luting cements or with light- activated ones. **Summary:** Fiber posts are used widely in the restoration of endodontically - treated teeth. Scientific evidence demonstrates that the mechanical performance of teeth restored with fiber posts in combination with resin luting cements is improved with respect to metallic post restorations. The post is cemented inside the root canal using low-modulus elastic polymer resins. In this study, the mechanical resistance of four different post – cement systems (1. carbon fiber C-Post/Composipost (RTD, St Egreve, France/ Bisco Dental) with C&B chemically-cured cement (Bisco Dental), 2. carbon fiber/glass fiber Aestheti-Plus (RTD, St Egreve, France/ Bisco Dental) post with C & B cement, 3. glass fiber Aestheti-Plus Post (Bisco Dental / RTD, St Egreve, France) with C&B cement, and 4. glass fiber Light-Post (Bisco Dental / RTD, St Egreve, France) with dual-curing Duo-Link cement (Bisco Dental) was assessed by means of a micro-mechanical pull-out test assisted by a simulation using the Finite

Element methodology. This *in vitro* test is specifically designed to accurately characterize the post/cement interface. The results show no significant difference among the adhesion of the various types of post – cement systems used. **PDF**

*Purton, D., Chandler, N., Qualtrough, A.. **Effect of thermocycling on the retention of glass fiber root canal posts.** *Quintessence Int. 34(5): 366-9 2003*

Objective: this study investigated the effects of thermocycling on the retention of glass fiber and resin posts. **Methods:** Forty premolar and canine tooth roots were imbedded in acrylic blocks shaped to fit into a retention device. The roots were randomly assigned to two groups of 20 to receive either Light-Posts (RTD, St Egreve, France) or Lucent Anchors (Dentatus) which were cemented into 9mm deep post spaces, with Panavia F resin cement. Each group was divided into two equal subgroups; one for thermocycling and the other to serve as a control. The thermocycled specimens were cycled 300 times between water baths at 5 degrees C and 55 degrees C, with a dwell time of 60 seconds in each. Control specimens were stored at 37 degrees C. The tensile force required to dislodge each post from its root was recorded and the data analyzed using Student's T-Tests. **Results:** There were no significant differences between the control and the thermocycled specimens. Light-Posts were significantly more retentive than the Lucent Anchor without thermocycling, but that distinction was not that apparent in the thermocycled groups. **Conclusions:** Glass-fiber-and-resin posts cemented with resin cement offer acceptable levels of retention and are not susceptible to reduced retention from thermocycling. Thermocycling should be given less emphasis in tests for the retention of root canal posts cemented with resin cements.

*Putignano, A, Poderi, G, Cerutti, A, Cury, A, Monticelli, F, Goracci, C, Ferrari, M. **An in vitro study on the adhesion of quartz fiber posts to radicular dentin.** *J Adhes Dent. 2007 Oct;9(5):463-7*

Purpose: To evaluate in vitro the bond strength at the adhesive interface between a quartz fiber post, different adhesive systems, and different composite cements. **Methods:** Thirty extracted single-rooted teeth were endodontically treated and divided into three groups (n=10). Quartz fiber posts (DT Light-Post) were cemented with the following materials: group I: Prime & Bond NT + Self Cure Activator, and Calibra as luting cement; group II: Prime & Bond NT + Self Cure Activator, and UniFil Core; group III: Unifil Bond in combination with Unifil Core. The specimens were processed for the push-out test to evaluate bond strength at the root dentin-cement-post interface. They were sectioned along the long axis of the post into 1-mm-thick slices. A total of 60 sections was obtained from group I. Group II provided 67 slices, while group III provided 69. Loading was performed at a crosshead speed of 0.5 mm/min until the post segment was dislodged from the root section. **Results:** There was no statistically significant difference between the three experimental groups. The mean bond strength obtained for group I was 9.81 +/- 5.40 MPa. For group II it was 12.06 +/- 6.25 MPa, and 9.80 +/- 5.01 MPa for group III. **Conclusions:**: All the materials tested were similar in terms of providing satisfactory bond strength when used for luting fiber posts. However, Unifil Core may be advantageous since it can also be used as a core buildup material, which simplifies the clinical procedures. **PDF**

Qualtrough, A. Chandler, N., Purton, D**. A comparison of the retention of tooth-colored posts.** *Quintessence Int 2003;34:199-201*

Objective: The aim of this in vitro study was to compare the retention of five different esthetic post systems of similar dimensions in extracted teeth using Titanium posts as controls. **Methods:** Sixty recently extracted single rooted caries-free teeth were sectioned horizontally and mounted in acrylic resin. The samples were randomly allocated into six groups of ten for post preparation. Post space preparation was carried out according to manufacturer's instructions. All posts were bonded using Panavia F. A 4mm hollow, metal sleeve was luted over the free end of each post prior to mounting in a universal testing machine, and the forces required to dislodge the posts using a crosshead speed of 5mm/min.were recorded. **Results:** It was found that the parallel-sided Light-Post (RTD, St Egreve, France) were significantly more retentive than all of the other posts. ParaPost Fiber White was more retentive than tapered DT Light-Posts (RTD, St Egreve, France) and Snow Posts. There was no significant difference between the retention of the stainless steel ParaPost and any of the other groups. **Conclusions:** Serrated, parallel-sided stainless steel posts were no more retentive than either parallel-sided or tapered tooth-colored posts in this study. Due to the nature of the bonding mechanism, the shape of the tooth-colored post may be less significant to its retention than it is for metal posts. **PDF**

Radovic, I., Mazzitelli, C., Chieffi, N., Ferrari, M. **Evaluation of the adhesion of fiber posts cemented using different adhesive approaches.** *Eur J Oral Sci. 2008 Dec;116(6):557-63.*

The aim of this study was to investigate the adhesion of fiber posts cemented with luting agents that utilize three currently available adhesive approaches: etch-and-rinse, self-etch, and self-adhesive. Forty-two intact single-rooted human premolars were used in the study. Teeth were divided into six groups. In each group, a different resin cement with its adhesive system (if needed) and a fiber post were used. The groups were classified, according to the adhesive approach, into the following three categories. (i) Etch-and-rinse groups: Calibra resin cement/XPBond adhesive + self-curing activator (SCA)/RadiX Fiber Post (Dentsply Caulk), FluoroCore 2 core build-up material/XPBond + SCA/RadiX Fiber Post (Dentsply Caulk), and MultiCore Flow luting and core build-up material/Excite DSC adhesive/FRC Postec Plus fiber post (Ivoclar Vivadent). (ii) Self-etch group: Panavia F 2.0/ED primer (Kuraray)/RadiX Fiber Post (Dentsply Caulk). (iii) Self-adhesive groups: experimental self-adhesive cement/RadiX Fiber Post (Dentsply Caulk), and RelyX Unicem/RelyX Fiber Post (3M ESPE). The adhesion between the post and the root canal walls was

assessed using the 'thin-slice' push-out test. In the test arrangement used, the self-etching approach may offer less favourable adhesion to root canal dentin in comparison with etch-and-rinse and self-adhesive approaches.

*Rödig, T, Nusime, AK, Konietschke, F, Attin, T. **Effects of different luting agents on bond strengths of fiber-reinforced composite posts to root canal dentin.** *J Adhes Dent. 2010 Jun;12(3):197-205. doi: 10.3290/j.jad.a18441.*

Purpose: To evaluate the bond strength between two fiber posts (FRC Postec and DT Light-Post) and different composite resins following different surface treatments of the posts. **Methods:** One hundred sixty extracted teeth were divided into sixteen groups (n = 10). After pretreatment of the post surface with (1) no treatment, (2) silanization, (3) sandblasting + silanization or (4) tribochemical coating, the posts were either luted with the resin cements provided by the manufacturers of the post system or with a core buildup material. Push-out tests were performed in a universal testing machine until the post segment was dislodged from the root section. Data were analyzed using ANOVA. Multiple comparisons were performed using Tukey's test. **Results:** FRC Postec achieved significantly higher bond strengths than DT Light-Post ($p < 0.0001$). Cementation with the core buildup material showed significantly higher bond strengths than the resin cement provided by the post manufacturers ($p < 0.0001$). **Conclusions:** Post type, type of surface treatment and type of resin cement were significant factors for bond strength. Luting with a core buildup material significantly increased the bond strengths. **PDF**

Rovatti, L., Mason, P.N., Dallari, B. , Dallari, A. **Influence of carved surface on carbon and quartz posts retention *J Dent Res. Vol 85 (Spec. Iss. C) Abstract #0554, PEF Division 2006 (www.dentalresearch.org)*

New quartz fiber endodontic posts with a carved surface have been recently marketed. Objectives: the purpose of this in vitro study is to compare the influence of different surfaces on carbon and quartz fiber posts luted into root canals. Methods: Into 20 extracted single-rooted human teeth, fiber-reinforced posts with a different surface (smooth and carved) have been luted by using a self-etching composite cement (All Bond II C & B, Bisco), so obtaining 4 groups of 5 elements each: 1) Composipost (RTD, France). 2) Composipost Retentive (RTD, France, with carved surface). 3) DT Light- Post (RTD, France). 4) DT Light-Post Retentive (RTD, France, with carved surface). In a further 5th group of 5 teeth, used as control, quartz fiber posts (DT Light-Post) etched with hydrofluoric acid 9.6 % for 15 sec have been luted with the same composite cement. Roots have been sectioned perpendicularly to long axis with a diamond wheel and the slices 2.2 mm thick so obtained have been subjected to pull-out test with Instron machine. Results: group 1: 27.12 MPa. group 2: 31.7 MPa. group 3: 29.83 MPa. group 4: 41.7 MPa. group 5: 32.4 MPa. **Conclusions:** a) quartz fiber posts confirmed to be more retentive than carbon fiber posts. b) a carved surface leads to a higher retention both in carbon and in quartz fiber posts. c) by using quartz fiber posts (etching is uneffective on carbon fibers), the carving of the surface leads to much higher values of retention than etching with hydrofluoric acid. d) all the above suggests that a macro-retention could be the right choice to increase the resistance to dislodgment of fiber-reinforced posts adhesively luted into root canals.

*Sadek, FT, Monticelli, F, Goracci, C, Tay, FR, Cardoso, PE, Ferrari, M. **Bond strength performance of different resin composites used as core materials around fiber posts.** *Dent Mater. 2007 Jan;23(1):95-9.*

Objectives:: To evaluate the microtensile bond strengths of different resin composites used as core materials around fiber posts. **Methods:** Forty D. T. Light-Posts (RTD, St Egreve, France) were randomly divided into eight groups, according to the resin composite used. They included two core materials specifically developed for core build-up--Group 1: Core-Flo (Bisco Inc.) and Group 2: UniFil Core (GC Corp.); three hybrid composites--Group 3: Tetric Ceram (Ivoclar-Vivadent), Group 4: Gradia Direct (GC Corp.), Group 5: Bisfil 2B (Bisco, Inc.); and three flowable composites--Group 6: AEliteflo (Bisco, Inc.), Group 7: Filtek Flow (3M ESPE) and Group 8: UniFil Flow (GC Corp). A cylindrical plastic matrix was placed around the silanized post and filled with the respective resin composite. Each bonded post provided five to eight sticks for microtensile testing. Each stick was loaded to failure under tension at a cross-head speed of 0.5mm/min. One-way ANOVA and Tukey's test were used for statistical analysis. Scanning electron microscopy (SEM) was used to evaluate the interface of the fractured sticks. **Results:** Resin composites exhibited a significant influence on microtensile bond strength ($p<0.05$). Core-Flo showed the highest bond strength (11.00+/-0.69 MPa) although it was not statistically significantly different from all groups, except from the flowable composites. Under SEM, all the composites adapted well to the fiber post, with a variable extent of voids observed along the fractured composite interfaces. **Significance:** Although good adaptation to the post surface was achieved, bond strength to fiber post remains relatively weak. Core build-up and hybrid composites are better alternatives to flowable composites as core build-up materials. **PDF**

Scotti, N., Rota, R,, Scansetti, M,, Migliaretti, G,, Pasqualini, D., Berutti, E.. **Fiber post adhesion to radicular dentin: The use of acid etching prior to a one-step self-etching adhesive.** *Quintessence Int. 2012 Jul-Aug;43(7):615-23.*

The aim of this study was to evaluate the bond strength of fiber posts luted with a one-step self-etching adhesive with the push-out test after phosphoric acid conditioning of the root dentin. Thirty-six single-rooted teeth were endodontically treated. Teeth were sectioned perpendicularly to the cemento-enamel junction, and a 10-mm post space was prepared with a calibrated bur. Specimens were then divided into three groups according to the adhesive protocol: A, total-etch three steps; B, self-etch one step; and C, 32% phosphoric acid conditioning and self-etch one step. Fiber posts were luted with self-curing resin-based cement. Teeth were cut in

1-mm slices and pushed until failure with an Instron machine. Results were statistically analyzed with the ANOVA and Bonferroni tests (P < .05). Two additional specimens from each group were examined under the scanning electron microscope (SEM). The 32% phosphoric acid significantly influenced the push-out bond strength of fiber posts luted with self-etch adhesives (P < .05). SEM analysis showed a continuous hybrid layer with resin tags and lateral branches in groups A and C, while group B showed smear layer dissolution with poor infiltration of the tubules.

*Simonetti , M, Radovic, I, Vano, M, Chieffi, N, Goracci ,C, Tognini, F, Ferrari, M . **The influence of operator variability on adhesive cementation of fiber posts.** *J Adhes Dent. 2006 Dec;8(6):421-5*

Purpose: The aim of this study was to evaluate the influence of the operator's experience on the outcome of fiber post cementation using an etch-and-rinse acetone-based adhesive. **Methods:** Fifteen human anterior teeth were used in the study. One trained operator performed the endodontic procedures and prepared the roots for the insertion and cementation of the posts. At this point, teeth were divided into 3 groups and distributed to 3 operators to lute the posts: an expert operator (EO), a moderately experienced operator (ME), and an operator with a low level of experience (LE). Quartz fiber posts (D. T. Light Post #1 or #2, (RTD, St Egreve, France) were used. Posts were cemented using Prime&Bond NT Dual Cure adhesive system (Dentsply Caulk) in combination with the dual-curing resin cement Calibra (Dentsply Caulk). The post retention was assessed with the "thin-slice" push-out test. One-way ANOVA was performed to examine the effect of the operator on push-out strength, followed by post-hoc multiple comparisons using Tukey's test, with the significance level set at alpha = 95%. **Results:** The results of push-out strength testing were as follows: EO (12.44+/-3.63 MPa), ME (11.68+/-2.64 MPa), LE (11.18+/-3.12 MPa). No statistically significant differences were determined among the three groups. **Conclusions:** There was no statistically significant difference in the retention measured for fiber posts luted by operators with different levels of clinical experience. Given the parameters of this investigation, the level of operator experience in luting fiber posts does not affect post retention under laboratory conditions. **PDF**

Spazzin , A.O., de Moraes, R.R., Cecchin, D., Farina, A.P., Carlini-Júnior, B., Correr-Sobrinho, L. **Morphological analysis of glass, carbon and glass/carbon fiber posts and bonding to self or dual-cured resin luting agents.** *J Appl Oral Sci. 2009 Sep-Oct;17(5):476-80.*

Objective: The aim of this study was to evaluate the morphology of glass (GF), carbon (CF) and glass/carbon (G/CF) fiber posts and their bond strength to self or dual-cured resin luting agents. **Methods:** Morphological analysis of each post type was conducted under scanning electron microscopy (SEM). Bond strength was evaluated by micro-tensile test after bisecting the posts and re-bonding the two halves with the luting agents. Data were subjected to two-way ANOVA and Tukey's test (alpha=0.05). Failure modes were evaluated under optical microscopy and SEM. **Results**: GF presented wider fibers and higher amount of matrix than CF, and G/CF presented carbon fibers surrounded by glass fibers, and both involved by matrix. For CF and GF, the dual-cured material presented significantly higher ($p<0.05$) bond strength than the self-cured agent. For the dual agent, CF presented similar bond strength to GF ($p>0.05$), but higher than that of G/CF ($p<0.05$). For the self-cured agent, no significant differences ($p>0.05$) were detected, irrespective of the post type. For GF and G/CF, all failures were considered mixed, while a predominance of adhesive failures was detected for CF. **Conclusion:** The bonding between fiber posts and luting agents was affected by the type of fibers and polymerization mode of the cement. When no surface treatment of the post is performed, the bonding between glass fiber post and dual-cured agent seems to be more reliable.

Sterzenbach, G., Rosentritt, M., Nettesheim, T, Naumann, M. **Adhesive cements as core build-ups for postendodontic restorations.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 959, 2009. (www.dentalresearch.org)*

Objectives: Recently composite resin core build-up materials were introduced as cements to retain endodontic posts. Thus, the question arises whether it would be possible to place endodontic posts and built up the core in an one-stage procedure with a self-adhesive composite resin cement. The null-hypothesis tested was that a self-adhesive cement in combination with a glass fiber post for post-and-core restoration is as able to withstand functional forces during thermocycling and mechanical loading (TCML) and additional linear loading as an etch-and-rinse approach with a conventional composite resin core build-up material. **Methods:** Human caries-free maxillary central incisors were divided into 4 groups (n=10). Teeth were endodontically treated and de-coronated 2mm above the cemento-enamel junction. Specimens were restored using glass fiber posts luted with different cements and composite resins for core build-up (cement/resin; cc=chemical curing; dc=dual curing): (I) RelyX Unicem/Clearfil Core-cc, (II) RelyX Unicem/ RelyX Unicem-dc (not indicated by manufacturer), (III) RelyX Unicem/LuxaCore-dc, and (IV) LuxaCore/Clearfil-cc. A 2mm-ferrule preparation was always performed. All specimens received adhesively luted all-ceramic crowns and were exposed to TCML (1.2 million loading cycles; 6,000 thermocycles 5° / 55°C) before static loading until failure. **Results:** Three specimens of group III and two of group II and IV, respectively failed during TCML (log rank: p=0.379). For these specimens the load capabilty value was set at 0N. The median fracture load values (min/max) in [N] were: group I = 295 (209/445), II = 166 (0/726), III = 241 (0/289) and IV = 201 (0/371) (Kruskal-Wallis test: p=0.091). The group I showed the highest percentage (80%) of restorable failures followed by group II (60%) (Chi-square test: p=0,028). **Conclusion:** It appears that even if not indicated by the manufacturer yet - in the future self-adhesive composite resins may be an alternative to conventional composite resin core materials.

*Sousa-Neto, M.D., Manicardi, C. A., Ozório, J.E.Z., Versiani, M. A., Pécora, J. D. **Influence of filling on the bond strength of fiber post.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #3938, 2010 (www.dentalresearch.org)*

Objectives: To evaluate the influence of filling on the interfacial bond strength of fiber posts (DT Light-Post; RTD St Egreve, France) to experimentally weakened root dentin restored with composite resin (Light Core). **Methods:** Fifty 17-mm long upper canine roots were used. After root canal preparation, the specimens were randomly divided into a control (n=10) (normal post preparation with no previous filling) and an experimental groups (n=40). In the experimental group, the canals were enlarged to produce a circumferential space of approximately 1mm between the fiber posts and the dentine walls, and the specimens were subdivided into four subgroups (n=10), according to the filling materials: G1=Endofill + gutta-percha; G2=AH Plus + gutta-percha; G3=Epiphany + gutta-percha; G4=Epiphany + Resilon. Twenty-four hours after obturation, the root canals were empty up to a depth of 12mm, the dentine was etched with 32% phosphoric acid (15s), rinsed with deionised water (30s) and gently dried with absorbent paper points. A 3-step adhesive system (All-Bond 2) was applied and the roots were bulk restored with a Bis-Core composite resin which was light-activated (20s) through the DT Light Post. After 24 h, the roots were sectioned transversely at the coronal, middle and apical regions producing 1-mm-thick slices. Push-out tests were performed and failure modes were observed under stereomicroscopy. Statistical analysis was performed by using ANOVA and Tukey's post-hoc tests (α=0.05). **Results:** Means in MPa (±SD) were 15.4±6.91 (control), 11.41±4.66 (G1); 9.97±3.41 (G2), 10.12±4.18 (G3), and 9.0±4.17 (G4). There was statistical difference between the control and the experimental groups($P<0.05$), but not between the post regions ($p>0.05$). The stereomicroscopy analysis showed higher percentage of adhesive failures in all groups. **Conclusion:** Previous root canal filling has reduced the bond strength of the adhesive system in the weakened group.

*Teixeira, CS., Silva-Sousa, YTC. Sousa-Neto, MD. **Bond strength of fiber posts to adhesively restored intracanal dentin** *J Dent Res.Vol 87 (Spec Iss A) Abstract #1744, 2008 (www.dentalresearch.org)*

Objectives: This ex vivo study evaluated the influence of different light-exposure times on the interfacial bond strength of fiber posts (D. T. Light-Post, RTD, St Egreve France / Bisco, Inc.) to experimentally weakened root dentin restored with composite resin (Light Core, Bisco Inc.). **Methods:** Sixty 17-mm long maxillary incisor roots were used. Twenty-four hours after obturation, the root canals were emptied up to a depth of 12 mm and 4 groups (n=15) were formed at random. In the 3 experimental groups (G1, G2 and G3), root dentin was flared to produce a 1-mm space between the fiber post and the canal walls. In the control group (G4), the roots were not experimentally weakened. The roots in the experimental groups were bulk restored with Light Core composite resin, which was light-activated through the D. T. Light-Post for either 40 s (G1), 80 s (G2) or 120 s (G3). The posts were cemented (Duo Link-Bisco Inc.) and, after 24 h, the roots were sectioned transversely at the coronal, middle and apical regions producing 1-mm-thick slices (±0.1 mm). Push-out tests were performed (0.5 mm/min, Instron 4444) and failure modes were observed under stereomicroscopy. **Results:** Means in MPa (±SD) were: GC=7.939 ±2.784; G1=10.36 ±2.99; G2=9.03 ± 2.69 and G3=10.28 ±3.16. Two-way ANOVA (a=0.05) indicated statistically significant difference among the groups ($p<0.001$), but not among the post regions ($p>0.05$). Comparing the weakened/reinforced groups, composite light-exposure time did not influence the results ($p>0.05$). There were a higher percentage of adhesive failures (in the post or dentin) in the control (73.33%) and experimental groups (85.18%). Cohesive failures occurred only in the weakened/reinforced roots (100%). **Conclusions:** Root reinforcement with composite resin and light transmitting posts provided higher bond strength to dentin than the control group, independently of the composite light-exposure time and analyzed region.

*Valandro, LF, Baldissara, P, Galhano, GA, Melo, RM, Mallmann, A, Scotti, R, Bottino, MA. **Effect of mechanical cycling on the push-out bond strength of fiber posts adhesively bonded to human root dentin.** *Oper Dent. 2007 Nov-Dec;32(6):579-88.*

This study evaluated the effect of mechanical cycling on the bond strength of fiber posts bonded to root dentin. The hypotheses examined were that bond strength is not changed after fatigue testing and bond strength does not present vast variations according to the type of fiber post. Sixty crownless, single-rooted human teeth were endodontically treated, with the space prepared at 12 mm. Thirty specimens received a quartz fiber post (Q-FRC) (D.T. Light-Post, RTD, St Egreve, France), and the remaining 30 specimens received a glass fiber post (G-FRC) (FRC Postec Plus). All the posts were resin luted (All-Bond+Duo-link), and each specimen was embedded in a cylinder with epoxy resin. The specimens were divided into six groups: G1- Q-FRC+no cycling; G2- Q-FRC+20,000 cycles (load: 50N; angle of 450; frequency: 8Hz); G3- Q-FRC+2,000,000 cycles; G4- G-FRC+no cycling; G5- G-FRC+20,000 cycles; G6- G-FRC+2,000,000 cycles. The specimens were cut perpendicular to their long axis, forming 2-mm thick disc-samples, which were submitted to the push-out test. ANOVA (alpha = .05) revealed that: (a) Q-FRC (7.1 +/- 2.2MPa) and G-FRC (6.9 +/- 2.1MPa) were statistically similar (p = 0.665); (b) the "no cycling" groups (7.0 +/- 2.4MPa), "20,000 cycles" groups (7.0 +/- 2.1MPa) and "2,000,000 cycles" groups (7.0 +/- 2.0MPa) were statistically similar (p = 0.996). It was concluded that mechanical cycling did not affect the bond strength of two fiber posts bonded to dentin.

Wang, VJ, Chen, YM, Yip, KH, Smales, RJ, Meng, QF, Chen, L. **Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test.** *Dent Mater. 2008 Mar;24(3):372-7. Epub 2007 Jul 25.*

Objective: To investigate regional root canal push-out bond strengths for two fiber-reinforced post types using two adhesive systems. **Methods**: The crowns of 24 recently extracted sound maxillary central incisors were sectioned transversely 2mm coronal to the labial cemento-enamel junction, and the roots treated endodontically. Following standardized post space preparations, fiber-reinforced posts (Composipost / C-Post; Aesthetic Plus; RTD, St Egreve, France/Bisco) were placed using two adhesive systems

(acid-etch One-Step Plus /C&B Cement; self-adhesive RelyX Unicem), in four equal groups. Push-out bond strength tests were performed at four sites in each root. Results were analyzed using split-plot ANOVA, with a=0.05 for statistical significance. **Results:** Aestheti-Plus quartz fiber-reinforced posts showed significantly higher push-out strengths than C-POST carbon fiber-reinforced posts (P<0.0001). The separate acid-etch adhesive system resulted in significantly higher bond strengths than the self-etch self-adhesive system (P<0.0001). Bond strengths decreased significantly from coronal to apical root canal regions (P<0.0001). **Significance:** The quartz fiber-reinforced post placed using the separate acid-etch adhesive system provided significantly better post retention than the carbon fiber-reinforced post placed using the self-etch self-adhesive system.

*Wrbas, KT, Kampe, MT, Schirrmeister, JF, Altenburger, MJ, Hellwig, E. **Retention of fiber posts dependent on different resin cements.** *Schweiz Monatsschr Zahnmed. 2006;116(1):18-24 (article in German)*

Tooth-coloured adhesive inserted fiber posts are used to restore endodontically treated teeth. In this investigation, the tensile bond strength of two different fiber posts systems (ER DentinPost and D.T. Light Post) in combination with five different resin cements was tested. The posts were inserted into artificial root canals in bovine dentin using Clearfil Core, RelyX Unicem, Panavia 21ex, Panavia F2.0 und Calibra. Titanium posts (ER-Kopfstift), inserted with zinc phosphate cement served as control group. ER DentinPost inserted with Clearfil Core had significantly higher tensile bond strengths than in combination with Panavia F2.0 (221.70 +/- 17.99 N) or Calibra (212.37 +/- 45.20 N). D.T. Light Post in combination with Calibra (338.20 +/- 46.40 N), Panavia F2.0 (321.69 +/- 40.11 N) and Panavia 21ex (290.41 +/- 55.28 N) showed significantly higher tensile bond strengths compared to adhesive cementation with RelyX Unicem (211.57 +/- 32.35 N) and Clearfil Core (131.67 +/- 51.72 N). The tensile bond strength of the control group was in the upper third of the values (315.43 +/- 51.38 N). Optical analysis of the post surface after decementation demonstrated in all cases adhesive-cohesive mixed fractures. The adhesion of resin cement to the fiber posts and resin cement to root canal dentin is influenced by different factors. The combination of fiber post systems with the type of resin cement has a great influence on the tensile bond strength.

*Wrbas, KT, Altenburger, MJ, Schirrmeister, F, Bitter, K., Kielbassa, AM. **Effect of adhesive resin cements and post surface silanization on the bond strengths of adhesively inserted fiber posts** *J Endod July s2007 Volume 33, Issue 7, Pages 840-843*

Abstract: This study evaluated the tensile bond strengths and the effect of silanization of fiber posts inserted with different adhesive systems. Sixty D.T. Light-Posts Size 1 (RTD St Egreve, France) were used. Thirty posts were pretreated with silane. The posts were cemented into form-congruent artificial root canals (12 mm) of bovine dentine. Six groups were formed: G1, Prime&Bond NT/Calibra; G2, Monobond-S+Prime&Bond NT/Calibra; G3, ED Primer/Panavia 21ex; G4, Monobond-S+ED Primer/Panavia 21ex; G5, RelyX Unicem; and G6, Monobond-S+RelyX Unicem. The mean (standard deviation) tensile bond strengths (megapascals) were 7.69 (0.85) for G1, 7.15 (1.01) for G2, 6.73 (0.85) for G3, 6.78 (0.97) for G4, 4.79 (0.58) for G5, and 4.74 (0.88) for G6. G1 achieved significantly higher bond strengths than G3 and G5; G3 had significantly higher values than G5 ($P < .05$; Scheffé procedure). Silanization had no significant effect ($P > .05$, one-way analysis of variance). Tensile bond strengths were significantly influenced by the type of resin cement. Silanization of fiber post surfaces seems to have no clinical relevance.

B. RESIN TO POST

Berthold, C., Holzschuh, B., Schuetz, E., Koch, AT, Powers, JM, Petschelt, A. **Bonding of frc-posts: influence of post length and surface design. *J Dent Res.Vol 92 (Spec Iss A) Abstract #1858, 2013 (www.dentalresearch.org)*

Objectives: To evaluate the influence of post length and post surface design on pull-out force and bond strength of conventionally and adhesively luted quartz-fiber-reinforced-composite posts [QFRCP]. Methods: 360 extracted bovine teeth were randomly assigned (n=20; 16 test and 2 control groups), root canal treated, filled and post space (6mm or 10mm) prepared. Custom-made smooth-surfaced QFRCPs [PSXRO] and macro-retentive (Macro-Lock Post) QFRCPs [MLXRO] (both RTD, France) were luted with Fuji Plus [FP], RelyX Unicem [RXU], Multilink Primer+Multilink [MLP] and LuxaBond+LuxaCore Z [LB]. A titanium-post [TiP] (NTI, Germany) (control) was luted with Ketac Cem [KC]. After water storage (24h, 37°C), pull-out-test was performed, bond strength calculated and analyzed using Kolmogorov-Smirnov-test ($p<0.05$), followed by Kruskal-Wallis-test and Mann-Whitney-U-test ($\alpha=0.05$). Failure mode was assessed under a stereomicroscope. Results: Bond strengths (MPa) were: KC (TiP), 4.1±0.6; FP (PSXRO+MLXRO), 6.5±2.1; RXU (PSXRO+MLXRO), 7.8±2.6; MLP_ML (PSXRO+MLXRO), 13.2±2.0; and LB_LCZ (PSXRO+MLXRO), 15.5±1.6. Influences of the post length on pull-out force (N) and post surface design on bond strength (MPa) were statistically significant ($p<0.05$). Bond strength (MPa), for the different post designs within one post length, was statistically significant different ($p<0.05$). Pull-out force (N), for the two post lengths within one post design, was statistically significant different ($p<0.05$), while the bond strength (MPa) was not ($p>0.05$). **Conclusion:** Post length and post surface design influenced bonding properties of conventionally and adhesively luted QFRCPs. The macro-retentive surface design and increased post length were in general beneficial to improve the bonding properties of the QFRCPs.

Berthold, C., Koch, A.T., Mitterhuber, B. Binus, S., Powers, J.M., Petschelt, A. **Bonding of frc-posts - influence of post surface roughness. *J Dent Res.Vol 92 (Spec Iss A) Abstract #1857, 2013 (www.dentalresearch.org)*

Objectives: To evaluate the influence of post surface roughness on bond strength of conventionally and adhesively luted quartz-fiber-reinforced-composite posts [QFRCP]. Methods: 180 extracted single rooted human teeth were randomly assigned (n=20; 8 test and 1 control group), root canal treated, filled and post space (size 6, 8mm) prepared. Custom-made smooth-surfaced QFRCPs [PSXRO] (Rz=5.48µm, Ra=0.82µm) and rough-surface QFRCPs (Macro-Lock Post, RTD, St Egreve, France) [PRXRO] (Rz=11.58µm, Ra=2.01µm) (both RTD, France) were luted with Fuji Plus [FP], RelyX Unicem [RXU], Multilink Primer+Multilink [MLP] and LuxaBond+LuxaCore Z [LB]. As control, a titanium-post [TiP] (Rz=5.37, Ra=0.79) (NTI, Germany) was luted with Ketac Cem [KC]. After water storage (24h, 37°C), pull-out-test (N) was performed, bond strength (MPa) calculated and analyzed using Kolmogorov-Smirnov-test ($p>0.05$), followed by ANOVA, post-hoc-tests and t-test ($\alpha=0.05$). Failure mode was assessed under a stereomicroscope. Results: The influence of the post surface roughness ($p< 0.001$) and the luting system selection ($p<0.001$) on the bond strength was statistically significant. The bond strengths for the QFRCPs with different surface roughness, within one luting system, were statistically significant different for FP and LB ($p<0.001$). The highest bond strength was found for PRXRO in combination with LB. **Conclusion:** In this in vitro study, post surface roughness and luting system selection significantly influenced the bond strength of conventionally and adhesively luted QFRCPs to human teeth. In general, the rough-surface design was beneficial for improving the bond strength.

Berthold, C, Binus, S.M, Koch, A.T., Powers, L.M., Petschelt, A. **Bonding Properties of FRC-posts - Influence of Post Pretreatment. *J Dent Res.Vol 92 (Spec Iss A) Abstract #1855, 2013 (www.dentalresearch.org)*

Objectives: To evaluate the influence of post pre-treatment by adhesive application on bond strength of adhesively luted quartz-fiber-reinforced-composite posts [QFRCP] to root canal dentin. **Methods:** 160 extracted single rooted bovine teeth were randomly assigned (n=20 per group), root canal treated, filled and post space (10mm) prepared. Size 6 custom-made smooth-surfaced QFRCPs [PSXRO] (Rz=5.5µm, Ra=0.8µm) (RTD, France) were cleaned with alcohol for pretreatment A and additionally pretreated with the respective dentin bonding system for pretreatment B. The posts were then luted with Multilink Primer_Multilink [ML], AdheSE_Multicore flow [MCF], SealBond Ultima (light-cured before post insertion)_CoreCem [CC], and LuxaBond_LuxaCore Z [LCZ], respectively. After water storage (24h, 37°C), pull-out-test (N) was performed, bond strength (MPa) calculated and analyzed using Kolmogorov-Smirnov-test ($p>0.05$), ANOVA and t-test ($\alpha=0.05$). Failure mode was assessed under a stereomicroscope and data analyzed using Kolmogorov-Smirnov-test ($p<0.05$) and Mann-Whitney-U-test. **Results:** The influence of the post pretreatment on the bond strength ($p<0.05$) was statistically significant, while the luting system selection ($p=0.31$) was not. Within one luting system, statistically significant differences in bond strength, for the two post pretreatment techniques, were found for ML ($p<0.05$). Overall, the main failure occurred between the post and the luting system (86%). The failure between post and luting system was reduced when using pretreatment B (83%) compared to pretreatment A (89%), but not statistically significant ($p=0.069$). **Conclusion**: In this in vitro study, the post pretreatment technique using Macro-Lock significantly influenced the bond strength of adhesively luted QFRCPs to bovine teeth. This effect might be explained due to improved bonding between the post and the ML luting system.

Berthold, C., B. Mitterhuber, B., Powers, J.M., Haapasalo, M. Petschelt, A. **Bonding of FRC-posts - Influence of post size, *J Dent Res.Vol 92 (Spec Iss A) Abstract #1856, 2013 (www.dentalresearch.org)*

Objectives: To evaluate the influence of post size on bond strength of conventionally and adhesively luted quartz-fiber-reinforced-composite posts [QFRCP]. **Methods:** 180 extracted single-rooted human teeth were randomly assigned (n=20; 8 test, 1 control group), root canal treated, filled, and post space (size 3 or 6; 8mm) prepared. Sizes 3 and 6 custom-made smooth-surfaced QFRCPs (Macro-Lock Post, RTD/ St Egreve France) [PSXRO] (Rz=5.48µm, Ra=0.82µm) (RTD, France) were luted with Fuji Plus [FP], RelyX Unicem [RXU], Multilink Primer+Multilink [MLP] and LuxaBond+LuxaCore Z [LB]. As control, a titanium-post [TiP] (Rz=5.37, Ra=0.79) (NTI, Germany) was luted with Ketac Cem [KC]. After water storage (24h, 37°C), pull-out-test (N) was performed, bond strength (MPa) calculated and analyzed using Kolmogorov-Smirnov-test ($p>0.05$), followed by ANOVA, post-hoc-tests and t-test ($\alpha=0.05$). Failure mode was assessed under a stereomicroscope. Results: The influence of post size ($p< 0.001$) and luting system selection ($p<0.001$) on the pull-pout force (N) and the bond strength (MPa) was statistically significant. Statistically significant differences were found for the two post sizes, within one luting system, in pull-out forces for RXU and MLP and in bond strength for FP and LB ($p<0.05$). **Conclusion:** In this in vitro study, post size and luting system selection significantly influenced the bond strength of conventionally and adhesively luted QFRCPs to human teeth. However, bonding properties did not distinctly improve when using bigger size posts. Therefore smaller size posts may be selected with the aim to maintain valuable root structure when considering only bonding features.

*Coelho, G., Santos, G., El-Mowafy. O., Hernique Rubo, J. **Diametral tensile strength of a resin composite core with nonmetallic prefabricated posts: an in vitro study.** *J Prosthet Dent. 2004 Apr;91(4):335-41.*

Statement of problem: A number of prefabricated nonmetallic posts are currently available for use in conjunction with resin composite cores before fabrication of crowns for endodontically treated teeth. Information is needed regarding the strength of the composite and the nature of attachment between its components. **Purpose:** The aim of this study was to determine the influence of different types of posts on the fracture resistance of a resin composite core material using the diametral tensile strength (DTS) test. **Methods:** Cylindrical specimens, 6 mm in diameter and 3 mm high, were prepared from resin composite (Tetric Ceram) and a

group of prefabricated posts (n=10) as follows: resin composite only (control); Vectrispost (VTS); FiberKor (FKR); Aestheti-Plus post (ATP); Light-Post (LTP); Dentorama post (DRM), and Para-Post (PRP) as a second control. Specimens were stored for 7 days in water at 37 degrees C and then subjected to DTS test in a universal testing machine until failure occurred and load was recorded (N). Mean values and SD for DTS values (MPA) were calculated, and data were analyzed statistically with 1-way analysis of variance, followed by the Tukey test (alpha=.05). Representative specimens from each group were examined with SEM to determine nature of failure. **Results:** Mean values (SD) in MPa for DTS were as follow: Control group: 49.64 (3.36); VTS: 29.77 (3.36); FKR: 31.9 (2.39); ATP: 28.92 (2.2); LTP: 34.26 (3.37); DRM: 33.45 (2.46), and PRP: 27.90 (2.40). Analysis of variance indicated significant differences among the groups (P<.05). SEM examination indicated that for PRP failure was adhesive in nature, whereas with all nonmetallic posts, cohesive failure was more predominant. **Conclusions:** The use of posts did not result in reinforcement of resin composite core when diametral tensile force was applied. When used with the core material, LTP, DRM, and FKR resulted in the highest DTS values, whereas PRP resulted in the lowest values. **Clinical Implications:** Some non-metallic fiber-reinforced posts, when used with a resin composite core, resulted in significantly higher Diametral Tensile Strength (DTS) compared with metal prefabricated posts. These higher DTS values meet minimum accepted values as provided by the ADA specifications for direct Type II composite materials. **PDF**

Dallari, A., Rovatti, L., Dallari, B., Mason, P. **Adhesion of different composites to carbon and quartz fiber endodontic posts: in vitro studies and preliminary reports**. *J Dent Res. Vol 82 IADR Abstract #1952, 2003 (www.dentalresearch.org)*

Objectives: Composites are used in post-endodontic core rebuildings when carbon and/or quartz fiber posts have been luted in root canals. Which composite is able to give the best clinical results in core rebuilding is still being discussed. The purpose of this study is to compare the adhesion of different composites to the surface of both carbon and quartz fiber posts. **Methods:** Two dual-curing (CoreRestore2 : Kerr & Luxacore:DMG) and two light-curing composites (Light-Core:Bisco & HelioMolar: Vivadent) were used to build a core on quartz fiber posts (Light-Post: RTD, St Egreve, France/Bisco). Posts were etched with Hydrofluoric acid 9.6% for 10 seconds. Two dual-curing (CoreRestore2 & BisCore: Bisco) and two light-curing composites (Renew: Bisco & Heliomolar) were used on carbon fiber posts (RTD/Bisco). In all, 8 groups of 10 specimens each were prepared. All the cores were built by using the same form (Composipost Core Form: RTD). Three slices (2.5mm thickness) in each specimen were obtained by using Leitz 600 device, and pull-out tests with Instron machine were performed. **Results:** on quartz fiber posts, CoreRestore 2: 393.9 N-29.02 MPa, Luxacore: 347 N-25.52 MPa, Light-Core: 313.7 N-21.31 MPa, Heliomolar: 182.4 N-13.22 MPa. On carbon fiber posts CoreRestore 2: 236.3 N-216.67 MPa, Bis-Core: 235.5 N-16.66 MPa, Renew: 234.8 N-16.61 MPa, Heliomolar: 228.6 N-16.15 MPa. **Conclusions:** The above results show that 1) the adhesion of composite resins to quartz fiber posts is higher than to carbon fiber posts, 2) on quartz fiber posts, dual-curing composites lead to a stronger adhesion that light–curing composites and 3) on carbon fiber posts, only negligible differences exist between dual and light-curing composites.

** Koch, AT, Binus, SM, Holzschuh, B, Petschelt, A, Powers, JM, Berthold, C. **Restoration of endodontically treated teeth with major hard tissue loss - influence of post surface design on pull-out bond strength of fiber-reinforced composite posts.** *Dent Traumatol. 2014 Aug;30(4):270-9. doi: 10.1111/edt.12089. Epub 2014 Jan 29.*

The aim was to evaluate the influence of post surface design and luting system on bond strength of quartz-fiber-reinforced composite posts (QFRCPs) luted to root canal dentin. **Methods:** Single-rooted bovine teeth (n = 650) were randomly assigned (13 groups, n = 50), sectioned, endodontically treated, filled, and post space (length 8 mm) prepared. Custom-made plain-surfaced fiber posts (PSXRO) and (both RTD) macroretentive Macro-Lock Post Illusion X-RO (MLXRO) were inserted into the post spaces using six luting systems: Ketac Cem (KC), Fuji Plus (FP), RelyX Unicem, Multilink Primer_Multilink, Sealbond Ultima_& CoreCem, and LuxaBond_& LuxaCore Z. As control, a titanium post was cemented with KC. After water storage (24 h, 37°C), pull-out test was performed, followed by failure mode assessment. Bond strength was calculated in MPa and analyzed using anova, Dunnett-T3-test, and Student's t-test with Bonferroni correction. **Results:** Post design and luting system significantly influenced the bond strength [MPa] ($P < 0.05$). Compared with the control 4.3 (1.5), all test groups exhibited higher bond strengths ($P < 0.05$), except for group PSXRO/KC 4.2 (1.0). The remaining bond strengths were PSXRO: FP 8.6 (1.5), RelyX Unicem 10.4 (3.4), Multilink Primer_Multilink 12.7 (3.0), SealBond Ultima_CoreCem 12.7 (3.0), LuxaBond_LuxaCore Z 15.7 (2.5), and MLXRO: KC 7.2 (2.2), FP 13.4 (2.5), RelyX Unicem 9.2 (2.9), Multilink Primer_Multilink 12.5 (4.5), SealBond Ultima_CoreCem 13.7 (4.6), LuxaBond_LuxaCore Z 20.6 (2.2). The bond strengths of MLXRO were higher than those of PSXRO when luted with KC, FP, and LuxaBond_LuxaCore Z ($P < 0.05$). **Conclusio**n: The post surface design and luting system selection influenced the bond strength of conventionally and adhesively luted.

Elsaka, SE.**Influence of chemical surface treatments on adhesion of fiber posts to composite resin core materials**. *Dent Mater. 2013 May;29(5):550-8. doi: 10.1016/j.dental.2013.03.004. Epub 2013 Mar 19*

Objective: This study evaluated the effect of different chemical surface treatments on the adhesion of resin-core materials to methacrylate resin-based glass fiber posts. **Methods:** Two types of glass fiber posts (Reblida post; VOCO and RelyX post; 3M ESPE) were divided into eight groups according to the surface treatment used; Gr 1 (control; no surface treatment), Gr 2 (silanization for 60s), Gr 3 (10% H_2O_2 for 5 min), Gr 4 (10% H_2O_2 for 10 min), Gr 5 (30% H_2O_2 for 5 min), Gr 6 (30% H_2O_2 for 10 min), Gr 7 (CH_2Cl_2 for 5 min) and Gr 8 (CH_2Cl_2 for 10 min). Two resin core materials (Grandio DC; VOCO and Filtek P60; 3M ESPE) were applied to each group for testing the adhesion using micropush-

out test. Failure types were examined with stereomicroscope and surface morphology of the posts was characterized after treatment using a scanning electron microscope (SEM). Data were analyzed using ANOVA and Tukey's test**. Results:** The type of post, surface treatment, and core material showed a significant effect on the micro- push-out bond strength ($P<0.001$). Groups treated with CH_2Cl_2 or 30% H_2O_2 solutions for 5 or 10 min showed the highest adhesion values for both types of posts with the core materials tested. Stereomicroscope showed that most failure modes were adhesive type of failures between post and core material. SEM analysis revealed that the fiber post surfaces were modified after chemical surface treatments. **Signifigance**: Application of CH_2Cl_2 or 30% H_2O_2 to the fiber post surfaces enhanced the adhesion to resin cores.

Güler AU, Kurt, M, Duran, I, Uludamar, A, Inan, O. **Effects of different acids and etching times on the bond strength of glass fiber-reinforced composite root canal posts to composite core material**. *Quintessence Int. 2012 Jan;43(1):e1-8.*

Objectives: To investigate the effects of different acids and etching times on the bond strength of glass **fiber**-reinforced composite (FRC) posts to composite core material. Methods: Twenty-six FRC posts (FRC Postec Plus) were randomly divided into 13 groups (each n = 2). One group received no surface treatment (control). The posts in the other groups were acid etched with 35% phosphoric acid and 5% and 9.6% hydrofluoric acid gel for four different etching times (30, 60, 120, and 180 seconds). A cylindrical polytetrafluoroethylene mold was placed around the treated posts and filled with dual-cure composite core material (Multi-Core Flow). All samples were light cured for 60 seconds. After 24 hours of water storage, the specimens were sectioned perpendicularly to the bonded interface under water cooling to obtain 2-mm **post**-and-core specimens. Eight specimens were made from each group. Push-out tests were performed at a crosshead speed of 0.5 mm/min using a universal testing machine. Data were analyzed by one-way ANOVA followed by the Tukey honestly significant difference test (alpha = .05). **Results:** The lowest bond strength was observed in the control group (12.51 megapascal [MPa]). No statistical significant difference was observed among group H5-120 (20.31 MPa), group H9-120 (20.55 MPa), or group P-180 (20.57 MPa) ($P > .05$). These groups demonstrated the highest bond strength values ($P < .05$). **Conclusions:** For the FRC posts, all acid-etching procedures tested showed significantly increased bond strength when compared with the control group. Acid-etching with 5% hydrofluoric acid and 9.6% hydrofluoric acid for 2 minutes and with 35% phosphoric acid for 3 minutes (groups H5-120, H9-120, and P-180, respectively) demonstrated the highest bond strength values between the FRC **post** and composite core material. Although the bond strength was increased by prolonged acid etching, the microstructure of the FRC posts might have been damaged.

*Kim, YK, Son, JS, Kim, KH, Kwon, TY. **A simple 2-step silane treatment for improved bonding durability of resin cement to quartz fiber post.** *J Endod. 2013 Oct;39(10):1287-90. doi: 10.1016/j.joen.2013.06.010. Epub 2013 Aug 7.*

Introduction: This study examined a clinically feasible protocol for improving hydrolytic stability using a 2-step silanization including a nonorganofunctional silane. **Methods:** The surfaces of 24 D.T. Light-Posts (RTD, St Egrege, France /Bisco Inc, Schaumburg, IL) were polished and assigned to the following 4 groups: M: 1-step silanization with Monobond-S (MS) (Ivoclar Vivadent, Schaan, Liechtenstein); BM: 2-step silanization with 5% 1,2-bis(triethoxysilyl)ethane and then MS; and HM and HBM: 1-step and 2-step silanization, respectively, after 24% H2O2 etching. Four resin composite cylinders (RelyX Unicem; 3M ESPE, St Paul, MN) were bonded on each surface according to a microshear testing protocol. All bonded samples were stored in water at 37°C for 24 hours, and half of them were then thermocycled 5000 times before microshear testing (n = 12). The failure modes were evaluated under an optical and scanning electron microscope. Water contact angles were measured on the post surfaces before and after silanization to estimate surface hydrophobicity. The results were statistically analyzed using 2-way analysis of variance and the Tukey test. **REsults:** The bond strengths for the BM and HBM groups were significantly higher than the M and HM groups at 5000 thermocycles ($P < .05$), whereas no significant differences were found between the 4 groups before thermocycling ($P > .05$). All debonded samples showed some fractured fibers. No significant difference in the hydrophobicity was found between the 1-step and 2-step silanized post surfaces ($P > .05$). **Conclusions:** The 2-step 1,2-bis(triethoxysilyl)ethane/MS treatment has potential as a silanization procedure for enhancing the hydrolytic stability of the fiber post/resin composite interface.

*Leforestier, E., Ceretti, I., Darque-Ceretti E., Laplanche, O., B**olla**, M. **Silanization effect of fiber posts on adherence to dental tissues.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #4481, 2010 (www.dentalresearch.org)*

Objectives: The main purpose of a post and core system is to keep a really damaged tooth in the jaw-bone, as long as it is possible. Due to the rapid progress in materials and bonding substances, the pulpless teeth treatments with quartz fiber posts, have been more and more used in daily practice. Thanks to their favorable mechanical properties, these posts give less failure than with a technique using cast metal posts. The aim of this study is to evaluate the influence of quartz fiber posts' silanization on the dental tissue's adherence. **Methods:** Eighteen extracted teeth were previously endodontically treated and randomly received a quartz fiber post without (group 1) or with silane layer on the surface (DT Light SL®). Both posts were bonded with a composite resin (XP Bond® adhesive+ Self Cure Activator®+ Core X Flow®). The push-out method was employed to measure bond strengths of the system, more exactly of 2 mm thick transversal discs of teeth's roots. Optic and scanning electron microscope (SEM) were used for visual macroscopic and microscopic examination of the samples before and after the push-out test. An energy dispersive X-ray spectrometry (EDX) gave the opportunity to analyze present elements. **Results:** The statistical analysis revealed a significant effect of the push-out force ($p<0, 05$) between the two groups, in favour of posts industrially treated with a silane coupling

agent (group 2). **Conclusions:** The failure mode is complex. A part of the luting agent has been found on some extracted fiber posts and samples. The silane seems to improve the composite resin with a positive incidence on the adherence to dental tissues.

*Meador, M., Broome, J., Ramp, L. **Diametral tensile bond strength of resin composite to fiber posts**. *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #0867, 2007 (www.dentalresearch.org)*

Adhesive reconstruction of endodontically treated teeth using fiber posts and resin composite materials has become increasingly popular. Recommendations include pre-treating the post with adhesive and/or silane. However, since the fiber post has a rough surface and is highly polymerized, it is questionable whether this step contributes to the bond. The diametral compression test (DCT) can be used to indirectly determine he bond of composite to a post (Santos JPD 91:335-41,2004). **Objective:** to determine the effect of various surface treatments on the bond of resin composite to fiber posts by DCT. **Methods:** Cylinders of resin composite (Z100, 3M ESPE, St. Paul, MN), were formed around the coronal end of three different fiber posts: D.T. Light-Post (Bisco/RTD, St Egreve, France), RelyX (3M ESPE) and UniCore (Ultradent). Four conditions (n=5) were tested: post surface untreated (Untx); cleaned with EtOH; cleaned and primed with All-Bond 2 (AB2); post coated with Vaseline to prevent bonding (Vas). A solid cylinder of composite (Sol) was used as a control (n=5). Samples were loaded to failure in diametral compression on an Instron Universal Testing Machine at a crosshead speed of 1 mm/min. DTS was calculated according to the formula: $2P/\pi*D*T$. Means were compared with ANOVA and Fisher's PLSD (alpha = 0.05). **Results:** Means in MPa (s.d) are given in the table. Means with the same superscript are not significantly different. Due to slight variations in size, comparisons between posts were not possible. **Conclusions:** For two of the three posts there was no statistically significant difference in bond regardless of surface treatment, but treatment of the post with a dentin bonding agent resulted in the highest bond strength to resin composite in all cases.

Pallottini, S., Llukacej, A., Monaco, C. Baldissara, P. **Fiber post bonding using self-etching and resin cements. *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #4493, 2010 (www.dentalresearch.org)*

Objectives: the fiber post bonding to root dentin relies on both chemical and micro-mechanical adhesion, this latter could be the main factor to generate retention strength. The aim of this study is to evaluate the push-out strength of different fiber post types when luted with a self-etching and a resin cement. **Methods**: 3 fiber post types a) Hi-Rem POP #2 (Overfibers); b) Macro-Lock Illusion (RTD) #2; c) RelyX Fiber Post (3M ESPE) and 2 cements were selected (self-etching RelyX Unicem, and resin RelyX ARC, 3M ESPE). 30 human teeth having narrow canals were randomly subdivided in six groups accordingly to each post/cement combination. Post space was prepared to obtain circular section canals using the manufacturer suggested burs. The specimens were subjected to 5000 thermal cycles then embedded in resin cylinders and sectioned obtaining >1mm thick slices for the push-out test. Data were analyzed with 1-way ANOVA and multiple comparison SNK test (alpha=.05). Failure distribution was determined by stereomicroscope/SEM observations (Mann-Witney test). **Results:** push-out strength of group a) and b) was significantly higher than that of group c) using both cements. The self-etching cement gave the highest values when used with group a) and b) posts: 15.2 and 15.4MPa, respectively; posts of group c) showed significantly lower values (9.7 and 11.8MPa with the self-etching and resin cement, respectively). Failures at the post/cement interface was significantly higher in group c) posts luted with self-etching cement. **Conclusion**: self-etching cement is a promising material for fiber post cementation. Its bonding to the dentin appeared more stable and stronger than that of the resin cement; the adhesion to the fiber post seems to be improved by a micro-retentive rough surface (Hi-Rem) or by an interlocking effect due to the threaded surface pattern (Macro-Lock). Smooth surface posts showed lower push-out values.

Perdigão J, Gomes G, Lee IK. **The effect of silane on the bond strengths of fiber posts**. *Dent Mater. 2006 Aug;22(8):752-8. Epub 2006 Jan 19.*

Objectives: Esthetic posts have been developed to maximize the foundation of esthetic restorations. The purpose of this study was to evaluate the effect of silane on the bond strength of three fiber-reinforced resin posts (fiber posts). **Methods:** Fifty-four extracted human maxillary central incisors and canines were endodontically treated. D.T. Light Post (DT, Bisco), FRC Postec (FR, Ivoclar Vivadent), and ParaPost Fiber White (PP, Coltène/Whaledent) were inserted using the resin adhesive system provided by the respective manufacturer. For half of the specimens in each group, the fiber posts were treated with a silane solution (Monobond S, Ivoclar Vivadent). A push-out test was performed on three different sections of each root to measure bond strengths. Data were analyzed with ANOVA and Bonferroni's post hoc test at $P<0.05$. **Results:** The use of silane did not result in any statistically significant difference at any level of the root. Silane did not result in any significant different bond strengths (MPa) for each of the posts. When the data were pooled, the use of silane did not result in statistically significant different bond strengths at $P>0.403$: No silane=12.7+/-8.4; Silane=14.1+/-7.0. The coronal third of the root (17.5+/-6.7) resulted in statistically greater bond strengths than the medium third (12.9+/-6.8) and than the apical third (9.8+/-7.3) at $P<0.002$ and $P<0.0001$, respectively. The medium third and the apical third resulted in no statistically significant different bond strengths from each other at $P>0.07$. The type of post did not result in statistically significant different bond strengths at $P>0.417$: DT=14.7+/-6.8 MPa; FR=13.3+/-6.6 MPa; PP=12.2+/-6.6 MPa. **Significance**: The use of a silane coupling agent did not increase the push-out bond strengths of the three fiber posts used in this study. All posts bonded to root dentin at the same magnitude. Bonding is more predictable at the most coronal level of the root.

Rathke, A, Haj-Omer ,D., Muche, R., Haller, B. **Effectiveness of bonding fiber posts to root canals and composite core build-ups.** *Eur J Oral Sci. 2009 Oct;117(5):604-10.*

This study investigated the effects of fiber posts, silanization, and luting agents on the interfacial strength to root dentin and composite cores. Root canals of 120 crownless human teeth were instrumented. Three different posts (opaque and translucent), with and without silane treatment, were bonded using etch-and-rinse, self-etch, and self-adhesive luting agents. The restored roots were built up with dual-curing composite. After storage in water for 24 h at 37 degrees C, 2-mm-thick slices were cut from each sample: one from the composite core and one from the restored root. Interfacial push-out bond strengths of the posts were determined in a universal testing machine. Failure modes were analyzed using scanning electron microscopy. The post type and the luting agent had significant effects on both the post-to-dentin and post-to-core strengths. Silanization did not significantly influence post-to-dentin strengths, but enhanced post-to-core strengths. With etch-and-rinse luting agents, debonding occurred predominantly between the post and the cement, while the self-etch and self-adhesive luting agents showed more failures on root dentin. No failures occurred between the composite core and the cement. The combination of translucent posts and etch-and-rinse dual-curing luting agents can positively influence the retention of fiber posts in root canals. Silanization seems to be less relevant for intra-root canal bonding, but may have beneficial effects on post-to-core strengths. **PDF**

Saelee, D., Sooksuntisakoonchai, N., Mangkrasan, V., Jindanusorn, D. **Bond strength between quartz fibre posts and core materials**. *J Dent Res. 81 IADR Abstract # 1154; 2002 (www.dentalresearch.org)*

Objectives: The purpose of this study was to determine the modes of failure and bond strength between quartz fiber post (Æstheti-Plus, RTD, St Egreve, France) and core build up materials (light cure composite resin, Alphadent, Dental Technologies, Inc., USA). **Methods:** Sixty quartz fiber posts were placed in extracted premolar and core were built up with light cure composite resin. Specimens were classified into 6 groups due to three diameters; 1.4, 1.8 and 2.1 millimeters at different heights; 2 and 4 millimeters. Universal Testing Machine (Lloyd LR30K, Lloyd Instruments, Ltd., England) was performed at the angulation of 45 degrees to the long axis of the tooth with cross head speed 0.2 millimeters/second. Each specimen was continuously loaded until fracture occurred. **Results:** It was found that the median load that caused core fracture out until fracture out of the post diameter 1.4, 1.8, and 2.1 millimeters were 244.3 N (95% CI: 218.2 N to 300.8 N), 393.5 N (95% CI: 373.8 N to 423.4 N), and 376.6 N (95% CI: 354.6N to 433.3N) respectively. The median fracture load measured from different post diameters was significantly different (P-value <0.001) whereas the load from various post heights was not significantly different (P-value=0.459). The modes of failure occurred between composite resin and post dentine (91.7%). No fractures were found within root, coronal tooth structure and post. **Conclusions:** From this study, it could be concluded that quartz fibers posts would not cause any coronal tooth structure and/or root fracture. Post diameter 1.8 and 2.1 were recommended due to higher bond strength between post and core materials.

Saelee, D., Swasdipanich, C., Gaveeyanon, E., Sooksuntisakoonchai, N., Chanatepaporn, P. **Effect of surface treatments on bond strength of fiber post.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #4480, 2010 (www.dentalresearch.org)*

Objectives: To evaluate the effect of hydrogen peroxide, and airborne particle abrasion on the bond strength of quartz fiber post. **Methods:** Forty five extracted single root premolars were randomly divided into three groups (n=15). The coronal part of the premolar was removed to allow the length of root to be approximately 14 mm. The endodontic treatment was then performed. Quartz fiber posts (Aestheti Plus®, RTD, France) which were subjected to (1) airborne particle abrasion (AB) with 50 µm aluminium oxide (2) etching with 50% hydrogen peroxide (HP) for 1 minute, and (3) no treatment (control group), were cemented to the root canal with resin cement (Paracore®, Coltène/Whaledent, France). Each root was sliced into 3 sections (i.e., the coronal, middle, and apical portions), giving rise to 45 specimens per group. A parallel, transverse root sections of 2.0 mm thickness, was cut from each specimen. The bond strength between cemented post and root dentine were determined by push-out test. Data were logarithmic transformed and analyzed by one-way ANOVA and Tukey test (α=0.05). **Results:** The mean bond strength of the control group was 6.755±3.806 MPa. Group AB exhibited the lowest mean bond strength (4.881±3.076 MPa), while the highest mean bond strength was obtained from group HP (10.215±3.982 MPa). One way ANOVA showed significant difference between all groups (P < .001). Post-hoc Tukey test revealed that bond strength of group HP was significantly higher when compared to group AB (p < .001) and control group (P = .024). There was no significant difference between group AB and control group (P < .054). **Conclusion:** The surface treatment of quart fiber post with 50% hydrogen peroxide for 1 minute significantly enhanced the bond strength of resin cement due to its ability to dissolve the epoxy resin matrix and leaving intact, undamaged quartz fibers for micro-mechanical retention.

Santos G.C.JR., Santos, MJMC, Johnson, N., Rizkalla, A.S. **Micro-tensile bond strength of different composite core foundation materials. *J Dent Res.Vol 92 (Spec Iss A) Abstract #0498, 2013 (www.dentalresearch.org)*

Objective: The aim of this study was to evaluate the micro-tensile bond strength (µTBS) of four resin composite core foundation materials and their respective post systems with and without silane surface treatment.
Method: Eight groups of posts (n=10) were divided into those with and without silane treatment. Four different core foundation materials were paired with their recommended posts and bonding agents as follows: Corecem + SealBond Ultima + Macro-Lock; Zircules + MPa+ Macro-Lock; RockCore + Prelude + IcePost; and ParaCore + ParaBond + ParaPost Fiber Lux. Following application of bonding agent, resin composite was injected around the post in a customized mold and light cured for 20s. For µTBS

specimens (1mm x 1mm cross-section and 8mm long) were produced. Testing was conducted using a universal Inston machine at a crosshead speed of 1mm/min. Statistical analysis was carried out using one-way ANOVA and Tukey-HSD test, p=0.05. **Result:** The μTBS values ranged from 18.59 MPa for Paracore without silane to 43.09 MPa for Corecem with silane. Silane treated Macro-Lock post paired with Zircules and Corecem exhibited the highest μTBS amongst groups, p<0.05, while ParaPost Fiber Lux without silane exhibited the lowest μTBS, p<0.05. SEM analysis demonstrated mixed adhesive/cohesive failures. FRC posts tend to lose surface fibers or break during stress failure, most notably in IcePost. **Conclusion**: Macro-Lock post associated with Corecem or Zircules, give the best results with and without silane. Silane coupling improved significantly the μTBS for three core foundation materials (p<0.05) with the exception of RockCore + IcePost.

*Shirinzad, M, Ebadi, Sh, Shokripour, M, Darabi, M. **An in vitro evaluation of the effect of four dentin bonding system on the bond strength between quartz fiber post and composite core.** *J Dent (Shiraz). 2014 Mar;15(1):22-7.*

Statement of problem: A strong bond of fiber post to resin core, as well as to dentin would critically ensure the durability of restorations in endodontically treated teeth. **Purpose:** The purpose of this study was to evaluate the effect of etch-and-rinse dentin bonding systems on the bond strength between resin core and fiber post after application of 24% hydrogen peroxide. **Method:** 24 fiber posts (RTD; St. Egrève, France) were treated with 24% hydrogen peroxide for 10 minutes. They were randomly divided into 4 groups (n=6) based on the bonding agent used: Group P: Prime&Bond, Group O: One Step, Group S: Single Bond and Group E: Excite. Each group was prepared according to the manufacturer's instructions. For all posts, a flowable composite core (ÆliteFlo; Bisco, USA) was built-up over the bonded area. Each specimen was sectioned to produce 2 sticks, 1mm in thickness and underwent microtensile bond strength (μTBS). Data were analyzed using one-way ANOVA at the 0.05 level. The fractured surfaces of all sticks were evaluated by stereomicroscope (× 20). Scanning electron microscopy(SEM) assessment of two sticks from each group was performed to evaluate the surface morphology. **Results:** The means and SDs of μTBS were: Group P: 10.95±1.74; Group S: 10.25±2.39; Group E: 9.52±2.07; and Group O: 9.12±1.34. There was no statistically significant difference in bond strength means between the groups tested (p> 0.05). **Conclusion:** The results of this study indicated the bonding agents used had no significant influence on the bond strength of fiber post to composite core.

*Soares, LP, Dias, KR, de Vasconcellos, AB, Sampaio, EM, Street, A**. Effects of different pretreatments on the bond strength of a dual-cure resin core material to various fiber-reinforced composite posts.** *Eur J Prosthodont Restor Dent. 2012 Mar;20(1):41-7.*

The aim of this study was to evaluate the effects of different pretreatments on the bond strength of a dual-cure resin core to 3 types of fiber posts. Bond strength was measured using a push-out design. One-sided t-Test of Hypothesis with unknown variance was performed (p-values < 5%). Sandblasting abrasion with 50 micro alumina particles at a specific distance, pressure and time was the only surface treatment in DT Light-Post (RTD St Egreve, France) and Transluma Post (Bisco Dental Products, Schaumburg, IL USA) that increased the bond strength to dual cure resin composite cores. FRC Postec Plus (Ivoclar, Schaan, FL) post did not shown an increase in bond strength in any group.

Wang, Y.J., Zhang, L., Chen, J.H., Goracci, C., Ferrari, M. **Influence of C-factor on the microtensile bond strength between fiber posts and resin luting agents.** *J Adhes Dent. 2008 Oct;10(5):385-91.*

Purpose: To propose an experimental model for assessing the interfacial strength between post and luting agent under clinically relevant conditions of post space diameter and cement layer thickness. **Methods:** DentinPost (Komet, DP) and GC (GC) glass fiber posts were tested. A sample of 22 posts per type was randomly subdivided into two equal groups based on the material for cementation: Panavia F 2.0 (Kuraray, PF) and MultiCore Flow (Ivoclar Vivadent, MF). Within each group, 2 subgroups were defined depending on the procedure for specimen preparation. In subgroup A (NO-M), the resin cement was incrementally stratified around a post centered within a plastic matrix until the latter was filled. In subgroup B (M), first a mold of resin cement with an artificial post space was created. Then, using the same cement, the post was luted into the dowel space. Microtensile beams were cut and loaded to measure post/cement interfacial strengths. For statistical analysis of the data, Kruskall-Wallis ANOVA was applied, followed by Dunn's Multiple Range test (p < 0.05). **Results:** Bond strengths in MPa were (median; 25th-75th percentile): DP/PF/M 4.5; 3.1-7.4; DP/PF/NO-M 9.2; 5.8-12.4; DP/MF/M 14.2; 10.2-20-6; DP/MF/NO-M 16.5; 13.1-21.7; GC/PF/M 7.6; 3.3-11.7; GC/PF/NO-M 7.8; 5.1-11-9; GC/MF/M 16.7; 14.3-3-22; GC/MF/NOM 20.4; 15.6-24. Irrespective of post type and of specimen preparation procedure, with or without mold, significantly higher bond strengths were measured for MF. On both post types, both cements achieved similar interfacial strengths regardless of the C-factor. **Conclusion:** The influence of a clinically relevant C-factor on the adhesion of resin cements to glass fiber posts was not statistically significant. **PDF**

*Wrbas, KT, Lenz, A, Schirrmeister, JF, Altenburger, MJ, Schemionek, W, Hellwig, E**. Bond strength of different resin composites to fiber-reinforced posts.** *Schweiz Monatsschr Zahnmed. 2006;116(2):136-41 (article in German)*

Endodontically treated teeth often have little coronal tooth tissue remaining and as such require a post to retain the core and the restoration. Therefore, tooth coloured adhesive inserted fiber posts in combination with resin based core material can be used. In this study, the tensile bond strength of core materials to fiber posts was investigated. Three different core materials, Clearfil Core, CoreRestore 2 and MultiCore Flow in combination with two different fiber posts systems, ER DentinPost and DT Light-Post,

were tested. The posts were shortened to the lengths of 15 mm.The specimens were obtained while the upper part (3 mm) of the posts was covered with standardized cylinders of the core materials. Clearfil Core in combination with the DT Light-Post (230.5 N +/- 42.2 N) and ER DentinPost (154. N +/- 33.6 N) had the highest tensile bond strengths of all groups. The tensile bond strength of CoreRestore 2 to D. T. Light-Post (149.9 N +/- 29.5 N) was higher than the tensile bond strengths of the combinations MultiCore Flow/D. T. Light-Post (140.9 N +/- 31.4 N) and Multi- Core Flow/ER DentinPost (122,. N +/-19,. N). The group CoreRestore 2TER DentinPost had the lowest tensile bond strengths (80,1 N ++/-19,4 N). The adhesion of the resin based core materials to the fiber posts is influenced by the post design and core materials. The combination of core materials with the type of fiber post has a great influence on the tensile bond strength.

*Yenisey, M, Kulunk, S. **Effects of chemical surface treatments of quartz and glass fiber posts on the retention of a composite resin.** *J Prosthet Dent. 2008 Jan;99(1):38-45*

Statement of problem: Failure of a fiber post and composite resin core often occurs at the junction between the 2 materials. This failure process requires better characterization. **Purpose:** The purpose of this study was to evaluate the effect of 2 chemical solvents, hydrogen peroxide and methylene chloride, on the shear bond strength of quartz and glass fiber posts to a composite resin. **Methods:** Twenty-four posts (3 +/-0.1 mm in length) were prepared for each quartz (Light-Post (LP)) and glass fiber (Cytec blanco (CB)) post. Posts were horizontally embedded in acrylic resin with half of the post diameter exposed. The exposed surfaces were successively ground with 400-, 800-, and 1200-grit silicon carbide papers, to ensure uniform smoothness. The specimens were divided into 3 subgroups (n=8) representing different surface treatment techniques, including application of silane for 60 seconds (S), etching with hydrogen peroxide for 20 minutes (H), and etching with methylene chloride for 5 seconds (M). Silane-treated specimens served as controls. A dual-polymerized composite resin (Tetric EvoCeram) was placed in a polytetrafluoroethylene mold (30 x 2 mm) positioned upon the post specimens and polymerized for 20 seconds with a light-emitting diode (LED) polymerization unit. The specimens were stored in water at 37 degrees C for 24 hours. Shear bond strength values (MPa) of posts and composite resin cores were measured using a universal testing machine with a crosshead speed of 0.5 mm/min. Data were analyzed by 2-way analysis of variance (ANOVA). Post hoc Tukey intervals for comparison among the 2 post materials and 3 surface treatment techniques were calculated (alpha =.05). The effect of the chemical surface treatments on glass and quartz fiber post surfaces were examined with a scanning electron microscope (SEM). **Results:** There were significant differences between the shear bond strength for LP and CB (P<.001). For all groups, the application of H showed the highest bond strength values. There was no significant difference between the S and M groups (P>.05). The SEM observations demonstrated that the fiber post surfaces were modified after chemical surface treatment techniques. **Conclusions:** The surface treatment of quartz and glass fiber posts with hydrogen peroxide significantly enhanced the shear bond strength of the composite resin tested due to its ability to dissolve the epoxy resin matrix used in each post. The lowest bond strength was obtained with M and S groups. Application of methylene chloride to the fiber post surfaces for 5 seconds was not effective in increasing the shear bond strength of the fiber post to composite resin.

Zicari F, De Munck J, Scotti R, Naert I, Van Meerbeek B. **Factors affecting the cement-post interface**. *Dent Mater. 2012 Mar;28(3):287-97. Epub 2011 Dec 12.*

Objectives: To evaluate the effect of different factors on the push-out bond strength of glass fiber posts luted in simulated (standard) root canals using different composite cements. **Methods:** Three types of glass-fiber root-canal posts with a different matrix, namely an epoxy resin (RelyX post, 3M ESPE), a proprietary composite resin (FRC-Plus post, Ivoclar-Vivadent), and a methacrylate resin (GC post, GC), and three types of composite cements, namely an etch-and-rinse Bis-GMA-based (Variolink II, Ivoclar-Vivadent), a self-etch 10-MDP-based (Clearfil Esthetic Cement, Kuraray) and a self-adhesive (RelyX Unicem, 3M ESPE) cement, were tested. Posts were either left untreated (control), were treated with silane, or coated with silicated alumina particles (Cojet system, 3M ESPE). Posts were inserted up to 9-mm depth into composite CAD-CAM blocks (Paradigm, 3M ESPE) in order to solely test the strength of the cement-post interface, while excluding interference of the cement-dentin interface. After 1-week storage at 37 °C, three sections (coronal, middle, apical) of 2-mm thickness were subjected to a push-out bond-strength test. **Results:** All three variables, namely the type of post, the composite cement and the post-surface pre-treatment, were found to significantly affect the push-out bond strength ($p<0.001$). Regarding the type of post, a significantly lower push-out bond strength was recorded for the FRC-Plus post (Ivoclar-Vivadent); regarding the composite cement, a significantly higher push-out bond strength was recorded for the self-adhesive cement Unicem (3M ESPE); and regarding the post-surface treatment, a significantly higher push-out bond strength was recorded when the post-surface was beforehand subjected to a Cojet (3M ESPE) combined sandblasting / silicatization surface pre-treatment. Many interactions between these three variables were found to be significant as well ($p<0.001$). Finally, the push-out bond strength was found to significantly reduce with depth from coronal to apical. **Significance:** Laboratory testing revealed that different variables like the type of post, the composite cement and the post-surface pre-treatment may influence the cement-post interface, making clear guidelines for routine clinical practice hard to define. Further long-term durability testing may help to clarify, and should therefore be encouraged.

V. Clinical Results

Ayad, MF, Bahannan, SA, Rosenstiel, SF.. **Reinforcement of thin-walled root canal structures for placement of esthetic dowels: A clinical report.** *Gen Dent. 2011 Jan-Feb;59(1):e18-21*

Thin-walled root canals always present a challenge to dentists to select a restorative treatment that does not further weaken the thin tooth structure. The prognosis of dowel and core restorations can be unpredictable. This clinical report describes the treatment of a patient with extensive caries extending into the root canal of an endodontically treated maxillary central incisor. The use of a flowable composite resin in combination with a quartz fiber reinforced post is described, resulting in the rehabilitation of a structurally compromised root canal with satisfactory esthetic and functional outcomes.

*Bitter, K., Noetzel, J., Stamm, O., Vaudt, J., Meyer-Lueckel, H., Neumann, K., Kielbassa, A. **Randomized clinical trial comparing the effects of post placement on failure rate of postendodontic restorations: Preliminary results of a mean period of 32 months**. *J Endod; 2009 35: 1477 -82*

Introduction: The aim of this randomized clinical trial was to assess whether the placement of a fiber post (DT Light Post) (DT) and the amount of residual coronal dentin affect the time to failure of single-unit postendodontic restorations. **Methods:** Ninety patients providing 120 teeth were selected. Three groups (n = 40) were defined on the basis of the amount of residual coronal dentin: 2-walls group, 2 or more coronal walls; 1-wall group, 1 coronal wall; no-wall group, no wall exceeding 2 mm above the gingival level. Within each group teeth were randomized and allocated to 2 intervention groups (n = 20), including subgroups no post (no root canal retention) and subgroups post (placement of DT). **Results:** After a mean observation period of 32.4 (13.7) months in subgroups no post, the failure rates were 10%, whereas in subgroups post, failure rates of 7% were observed (P = .318). In no-wall group post placement significantly affected the time to failure of total restorations (P = .029, log-rank test). Teeth without post retention revealed a significantly higher failure rate (31%) compared with teeth restored with post retention (7%). **Conclusions**: Within the observation time of the present study, fiber post placement was efficacious to reduce failures of postendodontic restorations only with teeth that exhibited no coronal walls. Post insertion for teeth showing a minor substance loss should be critically reconsidered.

Cagidiaco, MC, Goracci, C, Garcia-Godoy, F, Ferrari, M. **Clinical studies of fiber posts: a literature review.** *Int J Prosthodont. 2008 Jul-Aug;21(4):328-36*

Purpose: This literature review aimed to find answers to relevant questions regarding the clinical outcome of endontically treated teeth restored with fiber posts. **Methods**: All clinical studies published since 1990 in journals indexed in MEDLINE were retrieved by searching PubMed with the query terms "fiber posts and clinical studies." The reference list of the collected articles was also screened for further relevant citations. The strength of the evidence provided by the reviewed papers was assessed according to the criteria of evidence-based dentistry. **Results:** Five randomized controlled trials (RCTs) on fiber posts have been published in peer-reviewed journals. A meta-analysis is not applicable to these studies since they do not address the same specific clinical question. Retrospective and prospective trials without controls are also available. **Conclusions:** Two RCTs indicate that fiber-reinforced composite posts outperform metal posts in the restoration of endontically treated teeth. However, this evidence cannot be considered as conclusive. Longer-term RCTs would be desirable. The placement of a fiber-reinforced composite post protects against failure, especially under conditions of extensive coronal destruction. The most common type of failure with fiber-reinforced composite posts is debonding. **PDF**

*Cagidiaco, MC, Radovic, I, Simonetti M, Tay, F, Ferrari, M. **Clinical performance of fiber post restorations in endodontically treated teeth: 2-year results**. *Int J Prosthodont. 2007 May-Jun;20(3):293-8*

Purpose: This study evaluated the 2-year outcome of post-and-core restorative procedures in endodontically treated teeth. The effect of baseline factors (tooth type, number of residual coronal walls, and type of definitive restoration) on restoration failure was assessed. **Methods:** The consecutive sample design included 150 patients. A total of 162 teeth (57 anterior and 105 posterior) were restored. Sixty-nine teeth had 3 or 4 residual coronal walls, while 93 teeth had 2 or fewer walls. Crowns and direct resin composite restorations were placed in 121 and 41 teeth, respectively. After 23 to 25 months, all patients were evaluated. Logistic regression was used to identify the joint effect of variables recorded at baseline (P < .05). **Results:** The only failure modes observed were post debonding (4.3%, 2 in anterior teeth and 5 in posterior teeth) and endodontic failure (3.0%, 2 in anterior teeth and 3 in posterior teeth). All post debondings occurred in teeth with 2 or fewer coronal walls that were crown covered. All endodontic failures occurred in crown-covered teeth (1 failure in a tooth with 3 walls and the remaining 4 failures in teeth with 2 or fewer walls). Logistic regression found no statistical significance for any of the variables recorded at baseline. **Conclusions:** Restorations placed with the use of a fiber post (D. T. Light-Post, RTD, St Egreve, France) and core resulted in 4.3% post debondings and 3.0% endodontic failures after 2 years of clinical service. **PDF**

*Cagidiaco, MC., Garcia-Godoy, F., Vichi, A., Grandini, S., Goracci, C., Ferrari, M., **Placement of fiber prefabricated or custom made posts affects the 3-year survival of endodontically treated premolars**. *Am J Dent; 2008 21: 179-184*

Purpose: To assess whether the amount of residual coronal dentin and the placement of a prefabricated (D.T. Light-Post, RTD,St Egreve, France) (LP) or a customized fiber post (Everstick Post) (ES) have a significant influence on the 3-year survival of endodontically treated premolars. **Methods:** A sample of 345 patients provided 6 groups of 60 premolars in need of endodontic treatment. Groups were defined based on the amount of dentin left at the coronal level after endodontic treatment and before abutment build-up. Within each group, teeth were randomly divided into three Sub-groups (n=20). In Sub-group A, no root canal retention was provided for the coronal restoration. In Sub-groups B and C, LP and ES, respectively, were placed inside the root canal. All the teeth were finally restored with a single unit metal-ceramic crown. **Results:** Data were not affected by any loss of follow-up. The overall 36- month survival rate of crowned, endodontically treated premolars was 76.7%. The lowest survival rate was recorded for teeth restored without any root canal retention (62.5%). Teeth restored with LP had a survival rate higher (90.9%) than those restored with ES (76.7%). The Cox regression analysis showed that the presence of root canal retention was a significant factor for survival (P<0.05). The decrease in failure risk was higher in teeth restored with LP (HR=0.1;95% CI for HR=0;.09 to 0.34; P<0.001) than when using ES (HR= 0.5; 95% CI for HR=0.3 to 0.7; P=0.003). Teeth retaining one (HR=0.3; 95% CI for HR=0.2 to 0.7; P=0.003), two (HR=0.2; 95% CI for HR=0.1 to 0.5; P<0.001), or three coronal walls (HR=0.1; 95% CI for HR=0.05 to 0.3; P<0.001), had a significantly lower failure risk than teeth deprived even of the ferrule effect. Similar failure risks existed for teeth missing all the coronal walls, regardless of the presence or absence of a ferrule effect (P>0.05). Interaction terms were not significant (P>0.05). Post placement and the amount of residual coronal dentin affected the 3-year survival of endodontically treated premolars. **Clinical significance:** To obtain the highest success rate, endodontically treated premolars should be restored with a fiber post and a complete crown. The "ferrule" structure has a direct influence on the clinical success rate. **PDF**

Caine, Jr.,R. **Systematic review of survival analysis of fiber reinforced posts**. *J Dent Res. Vol 89 (Spec. Iss. A) Abstract #1002, 2010 (www.dentalresearch.org)*

Objectives: To compare the clinical failure rate of different types of prefabricated reinforced fiber posts used for the restoration of endodontically-treated teeth. M**ethods:** The inclusion criteria was a single endodontically-treated tooth with a fiber post system on a human study in English. The outcome failures on post systems for endodontically-treated teeth were a loss of post retention, post fracture, and root fracture. Ten studies met the inclusion criteria for a single tooth restoration of endodontically-teated tooth. The quality assessment was based on a random assignment, sample size calculation, inclusion/exclusion criteria, follow-up achieved, a blind design, patient follow-ups (intent to treat), and compatability of control and treatment groups. **Search strategy and data extraction**: Search terms were endodontic-treated tooth, fiber reinforced-post systems, success/failure, kaplan-Meier test, restoration, success/failure, and human studies. Selection of randomized or quasi-randomized clinical trials, endodontically-treated permanent teeth, prefabricated reinforced carbon fiber post. Electronic searches were performed in Cochrane, MEDLINE(OVID) and PubMed databases. Each study that met the inclusion criteria was assessed for the quality of the study. **Results:** The failure rate for prefabricated reinforced fiber posts was 7.8%.

Cloet, E, Debels, E, Naer, I. **Controlled clinical trial on the outcome of glass fiber composite cores versus wrought posts and cast cores for the restoration of endodontically treated teeth: A 5-year follow-up study.** *Int J Prosthodont. 2017 Jan/Feb;30(1):71-79. doi: 10.11607/ijp.4861.*

Purpose: The aim of this study was to compare the 5-year outcomes of glass fiber composite with cast posts and cores for the restoration of endodontically treated teeth. **Methods:** A total of 143 patients in need of 203 full ceramic restorations on endodontically treated teeth were included. After primary stratification based on the need for post or no post, teeth were randomly allotted to test group 1 (prefabricated glass fiber posts), 2 (custom-made glass fiber posts), or 3 (composite cores without posts). The control group was treated with gold alloy-based wrought posts and cast cores. Success (original present) and survival (present after intervention) probability lifetime curves, corrected for clustering, were drawn over the entire data set. **Results:** The mean follow-up time was 5.8 years (range: 0.5 to 7.2 years). At 5 years, the success and survival probabilities were 85.2% and 91.5%, respectively. Lifetime curves did not show any significant differences between the test and control groups for success (P = .85) or survival (P = .57). Moreover, no significant differences for success or survival could be found among the four groups (the three test groups and the control group). **Conclusion:** After 5 years of follow-up, cast gold and composite post-and-core systems on teeth with ceramic full restorations provided with a ferrule performed equally well.

Fazekas, A, Menyhart, K, Bodi, K, Jako, E **Restoration of root canal treated teeth using carbon fiber posts**. *Fogorv Sz 1998 Jun;91 (6):163-70*

Abstract/conclusions: The restoration of root canal treated teeth – because of the significant loss of tooth structure- is often achieved with post and core. However, posts may generate stresses, which lead to vertical root fracture and the loss of the tooth. Since post design, materials used and post space preparation has significant influence on vertical fracture prevalence, broad investigation is in progress to find the optimal procedure. During the last decade, new prefabricated passive posts were introduced for postendodontic restorations. In order to collect information, clinical trials have been performed on the reconstruction of root canal treated teeth using Carbon fibre posts (C-POST/ COMPOSIPOST; RTD, St Egreve, France). Adhesive technique was applied to

cement post in the root canal and for composite core reconstruction. The physical properties of the Carbon fibre posts and the composite are very close to those of the dentine. Post application is simple, does not require special skill and, for the patient, means minimum hazard. The position of the post was controlled by radiography. During the 24 months observation period, no failure was registered in patients treated (N=55). Hence, we attribute our good results to the homogenous reconstruction of the teeth. This procedure seems to be a good alternative to traditional cast metal dowel/cores or metal prefabricated posts.

Ferrari, M., Cagidiaco, C., Goracci, C., Vichi, A., Mason, P, N., Radovic, I., Tay, F. **Long-term retrospective study of the clinical performance of fiber posts** *.Am J Dent 2007;20:287-291.*

Purpose: To retrospectively evaluate the long-term clinical performance of three types of fiber posts after a service period of 7-11 years. **Methods:** 985 posts were included in the study: 615 Composiposts, 160 Æstethic Posts and 210 Æsthetic Plus Posts were placed into endodontically treated teeth. Four combinations of dentin adhesives/luting materials were used. Endodontic and prosthodontic results were recorded. **Results:** A 7-11% failure rate was recorded for the three types of posts. 79 failures in total were noted; 39 due to endodontic reasons, 1 root fracture, 1 fiber post fracture, 17 crown dislodgements and 21 due to post debonding. The mechanical failures were always related to the lack of coronal tooth structure. The results indicated that fiber posts in combination with bonding/luting materials may be used routinely for restoring endodontically treated teeth. Mechanical failure of restored teeth with fiber posts can be related to the amount of residual coronal structure. **PDF**

*Ferrari, M., Cagidiaco, M., Grandini, S., DeSantis, M., Goracci, C. **Post placement affects survival of endodontically treated premolars.** *J Dent Res 86(8):729-734, 2007*

Abstract: Clinical evidence is lacking regarding the influence of the amount of residual coronal dentin and of post placement on the failure risk of endodontically compromised teeth. The aim of this prospective clinical trial was to assess whether these factors significantly affect the two-year survival of restored pulpless premolars. A sample of 210 individuals provided six experimental groups of 40 premolars in need of endodontic treatment. Groups were defined on the amount of dentin left at the coronal level. Within each group, in half of the teeth selected at random, a fiber post (D. T. Light-Post, RTD, St. Egreve, France) was inserted inside the root canal, whereas in the remaining half of the premolars, no post was placed. All teeth were covered with a crown. The Cox regression analysis revealed that post placement resulted in a significant reduction of failure risk ($p < 0.001$). Failure risk was increased for teeth onder the "no ferrule" ($p < 0.001$) and "ferrule effect" conditions ($p < 0.004$). **PDF**

Ferrari, M., Vichi, A., and Garcia-Godoy, F. **Clinical evaluation of fiber-reinforced epoxy resin posts and cast post and cores.** *American Journal of Dentistry. 13: 15B-18B, 2000.*

Purpose: This retrospective study evaluated treatment outcome of cast post and core and Composipost systems after 4 yrs of clinical service. **Methods:** 200 patients were included in this study. They were divided into two groups of 100 endodontically treated teeth restored with a post. Group 1: Composipost systems were luted into root canal following the manufacturer's instructions. Group 2: Cast post and cores were cemented into root canal preparations with a traditional technique. The patients were recalled after 6 months, 1, 2 and 4 yrs and clinical and radiographic examinations were completed. Endodontic and prosthodontic results were recorded. **Results:** Group 1: 95% of the teeth restored with Composiposts showed clinical success; 3 of these samples were excluded for noncompliance and 2% showed endodontic failure. Group 2: Clinical success was found with 84% of teeth restored with cast post and core. 2% of these samples were excluded for noncompliance, 9% showed root fracture, 2% dislodgment of crown and 3% endodontic failure. Statistical evaluation showed significant differences between Groups 1 and 2 ($P<0.001$). The results of this retrospective study indicated that the Composipost system was superior to the conventional cast post and core systems after 4 years of clinical service. **PDF**

Ferrari, M., Vichi, A., Mannocci, F., and Mason, P. N. **Retrospective study of the clinical performance of fiber posts.** *American Journal of Dentistry. 13: 9B-13B, 2000.*

Purpose: To evaluate the clinical performance of C-Posts, Aestheti- Posts and Aestheti-Plus Posts (RTD, St Egreve, France) after a period of clinical service ranging from 1-6 yrs. **Methods:** 1,304 posts were included in the study: 840 Composiposts, 215 Aestheti-Posts and 249 Aestheti-Plus posts were placed into endodontically treated teeth. Four combinations of bonding/luting materials were used. The patients were recalled every 6 months and clinical and radiographic examinations were completed. Endodontic and prosthodontic results were recorded. Actuarial Life Table statistical analysis and Mantel-Haenszel comparison of survival curve have been performed at 95% level of confidence. **Results:** The 3.2% failure rate was due to two reasons: 25 posts debonded during removal of temporary restorations, and 16 teeth showed periapical lesions at the radiographic examination. No statistically significant differences were found among the four groups. The results of this retrospective study indicate that fiber posts in combination with bonding / luting materials can be routinely used. **PDF**

*Ferrari, M, Cagidiaco, M. ,Vichi, A., Grandini, S., Goracci, C. **Post placement and residual coronal structure affect root-treated premolars' survival.** *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #1385, 2007 (www.dentalresearch.org)*

Objective: to assess whether the amount of residual coronal dentin and the placement of a fiber post (D. T. Light-Post; RTD, St Egrève, France) or EverStick Post (Stick Tech, Turku, Finland) have a significant influence on the three-year survival of restored

pulpless premolars. **Methods:** A sample of 345 patients provided 6 cohorts of 60 premolars in need of endodontic treatment. Cohorts were defined based on the amount of dentin left at the coronal level after endodontic treatment and before abutment build-up. Within each cohort teeth were randomly divided into three Subgroups (n=20). In Subgroup A no endocanalar retention was provided for the coronal restoration. In Subgroups B and C a fiber post (RTD) and Stick Tech fibers (ST) respectively were placed inside the root canal. All the teeth were covered with porcelain fused to metal crowns. **Results:** Data were not affected by any loss to follow-up. The overall 36-month survival rate of crowned endodontically treated premolars was 76.70%. The lowest survival rate was recorded for teeth restored without any endocanalar retention (62.5%). Teeth restored with RTD had a survival rate higher (90.9%) than those restored with ST (76.7%). The Cox regression analysis showed that the presence of an endocanalar retention was a significant factor for survival ($p<0.05$). The decrease in failure risk was higher in teeth restored with RTD than when using ST. Teeth retaining one, two, or three coronal walls had a significantly lower failure risk than teeth deprived even of the ferrule effect. Similar failure risks existed for teeth missing all the coronal walls regardless of the presence or absence of a ferrule effect. Interaction terms were not significant ($p>0.05$). **Conclusion:** Post placement and the amount of residual coronal dentin affect the 3-year survival of endodontically treated premolars.

Ferrari, M., Cagidiaco, M., Magni,E., Cadenaro, M., Breschi, L. Goracci, C. **Clinical performance of fiber post restorations: 2-year results.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 1015, 2009. (www.dentalresearch.org)*

Objectives: To evaluate the 2-year outcome of post-retained restorations of endodontically treated teeth. **Methods:** A consecutive sample of 45 patients was collected and 45 premolars (25 maxillary, 20 mandibular) were restored. RelyX Fiber posts (3M ESPE) were luted with RelyX Unicem (3M ESPE) following manufacturer's instructions. Filtek Flow (3M ESPE) was used to build-up the abutment, that was covered with an all-ceramic crown (Empress II, Ivoclar-Vivadent). Baseline factors such as tooth type and number of residual coronal walls were noted. After 23-25 months patients were recalled and two operators who had been previously calibrated separately performed a clinical and radiographic examination. The following events were considered as failures: post debonding, post fracture, root fracture, failure of the core portion requiring a new coronal restoration, displacement of the crown, endodontic and periradicular conditions requiring endodontic retreatment. Kaplan-Meier plots were constructed. The Cox regression analysis was applied to assess the influence of baseline factors on failure occurrence. **Results:** One patient could not be re-evaluated. Radiographic signs of periapical pathology were observed in 3 teeth, though symptoms were reported for only 1 of them. The 3 teeth showing periapical lesions also had the post de-bonded. Overall, 4 teeth with 2 residual coronal walls exhibited post de-bonding along with marginal leakage. All de-bonded posts were re-luted and the teeth were thus restored to function. The survival rate of post-retained restorations in this study was similar to the rates reported in previous clinical trials. The Cox regression analysis did not reveal any significant influence of baseline factors on failure occurrence. **Conclusions:** Restorations of endodontically treated premolars retained by fiber posts luted with a self-adhesive resin cement showed a satisfactory success rate after 2 years of clinical service. All the 4 recorded failures consisted of post de-bonding, while no irreparable failures such as root fracture occurred.

*Ferrari, M.,Vichi, A., Fadda, G.M., Cagidiaco, M.C., Tay, F.R., Breschi, L., Polimeni, A., Goracci, C. **A randomized controlled trial of endodontically treated and restored premolars**. *doi: 10.1177/0022034512447949 JDR July 2012 vol. 91 no. 7 suppl S72-S78*

This in vivo study examined the contribution of remaining coronal dentin and placement of a prefabricated (LP) or customized fiber post (ES) to the six-year survival of endodontically treated premolars. A sample of 345 patients provided 6 groups of 60 premolars each in need of endodontic treatment. Groups were classified according to the number of remaining coronal walls before abutment build-up. Within each group, teeth were allocated to one of three subgroups: (A) no post retention; (B) LP; or (C) ES (N = 20). All teeth were protected with a crown. Cox regression analysis revealed that fiber post retention significantly improved tooth survival ($p < 0.001$). Failure risk was lower in teeth restored with prefabricated ($p = 0.001$) than with customized posts ($p = 0.009$). Teeth with one ($p = 0.004$), two ($p < 0.001$), and three coronal walls ($p < 0.001$) had significantly lower failure risks than those without ferrule. Similar failure risks existed for teeth without coronal walls, regardless of the presence/absence of ferrule ($p = 0.151$). Regardless of the restorative procedure, the preservation of at least one coronal wall significantly reduced failure risk.
PDF

Gbadebo, OS, Ajayi, DM, Dosumu Oyekunle, OO, Shaba, PO. **Randomized clinical study comparing metallic and glass fiber post in restoration of endodontically treated teeth.** *Indian J Dent Res. 2014 Jan-Feb;25(1):58-63. doi: 10.4103/0970-9290.131126.*

Background: Post-retained crowns are indicated for endodontically treated teeth (ETT) with severely damaged coronal tissue. Metallic custom and prefabricated posts have been used over the years, however, due to unacceptable color, extreme rigidity and corrosion, fiber posts, which are flexible, aesthetically pleasing and have modulus of elasticity comparable with dentin were introduced. Aim: To compare clinical performance of metallic and glass fiber posts in restoration of ETT. **Methods:** 40 ETT requiring post retained restorations were included. These teeth were randomly allocated into 2 groups. Twenty teeth were restored using a glass fiber-reinforced post (FRP) and 20 others received stainless steel Parapost (PP), each in combination with composite core buildups. Patients were observed at 1 and 6 months after post placement and cementation of porcelain fused to metal (PFM) crown. Marginal gap consideration, post retention, post fracture, root fracture, crown fracture, crown de-cementation and loss of restoration were part of the data recorded. All teeth were assessed clinically and radiographically. Fisher's exact test was used for

categorical values while log-rank test was used for descriptive statistical analysis. **Results:** One tooth in the PP group failed, secondary to de-cementation of the PFM crown giving a 2.5% overall failure while none in the FRP group failed. The survival rate of FRP was thus 100% while it was 97.5% in the PP group. This however was not statistically significant (log-rank test, P = 0.32). **Conclusion:** Glass FRPs performed better than the metallic post based on short-term clinical performance.

*Ghavamnasiri, M, Maleknejad, F, Ameri, H, Moghaddas, MJ, Farzaneh, F, Chasteen, JE. **. A retrospective clinical evaluation of success rate in endodontic-treated premolars restored with composite resin and fiber reinforced composite posts**. *J Conserv Dent. 2011 Oct;14(4):378-82. doi: 10.4103/0972-0707.87203.*

Background: The aim of this retrospective study was to assess the survival rate and causes of failure of quartz fiber posts used to restore endodontically treated teeth. **Methods:** Thirty-eight patients with endodontically treated premolar and anterior teeth that were then restored with a coronoradicular quartz fiber post and extensive composite resin restorations were selected for participation in the study. The age of the restorations ranged from 1 to 6 years. Survival probabilities of the restorations as well as causes of failures were analyzed using the Kaplan-Meier analysis and the Logistic regression ($\alpha = 0.05$). **Results:** The overall cumulative survival rate (48.8%) was determined, while the survival probabilities after 1, 2, 4, 5, and 6 years of service were 88.37%, 60.95%, 45.71%, 32.65%, and 0%, respectively. **Conclusions:** The survival probability of endodontically treated teeth restored with a quartz fiber post and composite restorations is associated with the dental arch.

Glazer, B. **Restoration of endodontically treated teeth with carbon fibre posts - A prospective study.** *Journal of the Canadian Dental Association. 66: 613-618, 2000.*

Abstract*:* A prospective study was started in 1995 to evaluate the success of carbon fibre reinforced epoxy resin (Composipost) posts used to restore endodontically treated teeth. All the teeth in the study had lost more than 50% of their coronal structure. **Methods***:* Fifty-nine carbon fibre Composiposts (RTD, St Egreve, France) cemented with C & B Metabond and built up with Core Paste cores were placed into the teeth of 47 patients. Each tooth received a full-coverage restoration (porcelain fused to metal crown) and was followed for 6.7-45.4 months (average = 28.0 months, standard deviation = 10.7). **Results:** Results for 52 teeth in 42 patients were analyzed. There were no fractures. The overall failure rate was 7.7% and the cumulative survival rate was 89.6% at the end of the follow-up period. The only statistically significant finding (p=0.04) was that posts in lower premolars were at higher risk of failure. **Conclusion:** Composipost posts are among the most predictable systems available today. Composipost posts in the upper anterior teeth are associated with a higher success rate and longer life than those placed in premolars, especially lower premolars. This study contributes to the growing body of evidence that supports the use of Composipost posts in the restoration of endodontically treated teeth. **PDF**

*Goracci, C. ,Cagidiaco, M., Cagidiaco, E.,Vichi, A., Grandini, S., Ferrari, M.. **Effects of oral environment and occlusal wear on FRC-posts integrity**. *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #0131, 2007 (www.dentalresearch.org)*

Objectives: To evaluate whether the exposure to the oral environment and occlusal wear during function affects the morphological integrity of fiber posts underlying a luted crown or a direct composite restoration. Methods: Two groups of endodontically treated teeth restored with D. T. Light- Posts (RTD, St. Egreve, France) were investigated. Group 1 included ten crowned teeth in which the abutment had the post head exposed on the surface. Group 2 included ten teeth directly restored with resin composite and presenting with the post head exposed on the occlusal surface of the restoration. For baseline evaluation, polyether impressions (Permadyne, 3M ESPE) were taken of the abutments before crown luting in Group 1, and of the restorations occlusal surfaces immediately after polishing in Group 2. Results: After a 5-year period of clinical service, polyether impressions were taken again for each experimental tooth. All the impressions were developed with epoxy resin and observed under a scanning electron microscope (Jeol, Tokyo, Japan), in order to assess whether the post surface underwent structural changes due to water uptake (Groups 1 and 2) and/or occlusal wear (Group 2) during the clinical function. Results: In neither group microscopic signs of post surface degradation due to water uptake were seen. In Group 2 wear signs were visible on the exposed post surface, as well as on the surface of the direct composite. Conclusion: Over a 5-year period, in case the fiber post surface is exposed on the top of the abutment, the seal provided by the crown effectively protects the fiber post against water uptake. When the post surface is exposed in a direct resin restoration, it does not show evident morphological changes related to water degradation, although it exhibits a loss of structure due to occlusal wear.

*Grandini, S., Goracci, C., Tay, F,.Grandini, R., Ferrari, M **Clinical evaluation of the use of fiber posts and direct resin restorations for endodontically treated teeth** *Int J Prosthodont 2005;18:399–404.*

Purpose: Restoration of root-treated teeth is routinely performed in clinical practice with a choice of therapeutic options, considering many factors to provide optimal mechanical properties, esthetics, and longevity. The aim of the present work was to present a preliminary clinical report on the use of fiber posts and direct resin composites for restoring root-treated teeth. **Methods:** Thirty-eight anterior and 62 posterior endodontically treated teeth were selected from 3 private prosthodontic offices. The protocol used included endodontic treatment, with translucent fiber posts (D. T. Light-Post, RTD St Egreve, France) bonded to the post-space using a '1-bottle' adhesive (One-Step, Bisco) and a dual-cure resin cement (Duo-Link, Bisco). Direct resin restorations were performed using a micro-hybrid resin composite (Gradia Direct, GC) and a layering technique. Both opaque dentin and enamel and translucent enamel shades were used. **Results:** Patients were recalled after 6, 12, 24, and 30 months, and the restorations

assessed according to predetermined clinical and radiographic criteria. These clinician-mediated evaluation methods confirmed the good clinical performance of the restorations. **Conclusions:** Restoration of endodontically treated teeth with fiber posts and direct resin composites is a treatment option, that in the short term conserves remaining tooth structure and results in good patient compliance. **PDF**

Guldener, KA, Lanzrein, CL, Siegrist Guldener, BE, Lang, NP, Ramseier, CA, Salvi, GE. **Long-term Clinical Outcomes of Endodontically Treated Teeth Restored with or without Fiber Post-retained Single-unit Restorations**. *J Endod. 2016 Dec 7. pii: S0099-2399(16)30735-X. doi: 10.1016/j.joen.2016.10.008. [Epub ahead of print]*

Introduction: The aim of the present study was to evaluate both survival and failure rates of endodontically treated teeth restored with or without fiber post-retained restorations after a mean observation period of at least 5 years. **Methods:** A total of 144 single-rooted and multi-rooted teeth in 100 subjects were endodontically treated following a predetermined aseptic protocol and restored with either a fiber post and a composite core or a composite filling without intra-radicular retention. A fiber post was cemented when the teeth presented with only 1 wall and/or less than one third of the remaining height of the clinical crown. After a comprehensive treatment plan, the teeth were restored with either a direct composite restoration or a single-unit crown. Endodontically treated teeth supporting fixed and removable dental prostheses and telescopic crowns were excluded from the analysis. Success was defined as tooth survival without any treatment of biological and/or technical complications. **Results:** The overall tooth survival rate was 89.6% after a mean observation time of 8.8 ± 2.3 years. The survival rate of teeth with a fiber post amounted to 94.3%, and for teeth without a post, it was 76.3% ($P < .001$). The main reason for tooth loss was root fracture (9.7%). No loss of post retention was observed. Successfully treated teeth without any biological and/or technical complications and requiring no additional treatment during the entire observation period amounted to 79.9%. **Conclusions:** Endodontically treated teeth restored with fiber posts and either a direct composite restoration or a single-unit crown yielded higher survival and success rates compared with teeth restored without fiber posts. Vertical fractures of roots not containing a post represented a frequently encountered and serious problem.

Juloski, J, Fadda, GM, Monticelli, F, Fajó-Pascual, M, Goracci, C, Ferrari, M. **Four-year survival of endodontically treated premolars restored with fiber posts.** *J Dent Res. 2014 Mar 19;93(7 suppl):52S-58S. [Epub ahead of print]*

The objective of this prospective clinical trial was to investigate the influence of the residual coronal structure of endodontically treated teeth and the type of cement used for luting fiber posts on four-year clinical survival. Two groups (n = 60) were defined, depending on the amount of residual coronal dentin after abutment build-up and final preparation: (1) more than 50% of coronal residual structure; and (2) equal to or less than 50% of coronal residual structure. Within each group, teeth were randomly divided into 2 subgroups (n = 30) according to the material used for luting fiber posts: (A) resin core build-up material, Gradia Core; or (B) self-adhesive universal cement GCem Automix. The rate of success was assessed based on clinical and intra-oral radiographic examinations at the follow-up after 6, 12, 24, 36, and 48 months. The highest 48-month success and survival rates were recorded in group 1A (90% and 100%, respectively), whereas teeth in group 2B exhibited the lowest performance (63.3% success rate, 86.6% survival rate). Cox regression analysis revealed that neither the amount of coronal residual structure nor the luting material significantly influenced the failure risk ($p > .05$).

Malferrari S, Monaco C, Scotti R. **Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts.** Int J Prosthodont. 2003 Jan-Feb;16(1):39-44.

Purpose: This prospective clinical follow-up evaluated the acceptability of quartz fiber-reinforced epoxy posts used in endodontically treated teeth over a 30-month period. **Methods:** In 132 patients, 180 endodontically treated teeth were restored using AEstheti-Plus quartz-fiber posts. The posts were luted with the All-Bond 2 adhesive system and C&B Resin Cement according to the manufacturer's recommendations. The core was made with Core-Flo or Bis-Core, and all-ceramic crowns or metal-ceramic crowns were applied as final restorations. The parameters considered as clinical failure were displacement, detachment, or fracture of posts; core or root fracture; and crown or prosthesis decementation. Patients were reevaluated at 6, 12, 24, and 30 months. **Results:** One cohesive failure involving a margin of the composite core was observed after 2 weeks, and two adhesive fractures were seen after 2 months. These failures were located between the cement and the dentin walls of the canals. All three failures occurred during removal of the temporary crown. The percentage of failures was thus 1.7% over a 30-month period, but it was possible to successfully replace the restoration in all three failed cases. **Conclusions:** Over a 30-month period, the rehabilitation of endodontically treated teeth using quartz-fiber posts showed good clinical results. No crown or prosthesis decementation was observed, and no post, core, or root fractures were recorded. **PDF**

Malferrari, S, Baldissara, P, Arcidiacono, A, **Translucent Quartz Fiber Posts: a 20 Month In vivo Study**. *J Dent Res. 81 IADR Abstract #2656; 2002 (www.dentalresearch.org)*

Abstract: In the attempt to achieve the best-performing post and core restoration, many post systems have been studied. In the recent past, the aesthetic fiber posts, in combination with resin luting cement, have been proposed to provide a reliable rehabilita-

the dentin) and aesthetic characteristics that enhance a final rehabilitation with an all-ceramic crown…with satisfying results. **Objectives:** The purpose of this study was to evaluate the clinical behavior of 84 endodontically treated teeth treated with translucent quartz fiber posts. Thirty four teeth recieved a Light-Post (RTD/Bisco Dental) and 50 teeth received the Endo Light-Post (RTD, St. Egreve, France). To perform the cementation, Bisco One-Step and dual – cure Duo-Link (Bisco) were utilized. The luting cement was polymerized through the translucency of the post. **Methods:** All of the core restorations were performed using Core-Flo (Bisco) or Bis-Core (Bisco) composite resin and finalized with an all-ceramic crown. In accordance with the international literature, data, useful for the longitudinal evaluations, were recorded on diagrams. The survival rate of the post and core was valuated after 2 weeks, 1, 3, 6, 12 and 20 months. Post displacement or detachment, post fracture, restoration fracture and root fracture were investigated. **Results:** No failures took place up to the present day. **Conclusions:** According to these results, and within the limitations of this study, it is possible to assume that the clinical performance of these translucent fiber posts is successful. Further data will be needed for long-term clinical evaluations of the outcome.

Mannocci, F, Bertelli, E, Sherriff, M, Watson, TF, Ford, TR. **Three-year clinical comparison of survival of endodontically treated teeth restored with either full cast coverage or with direct composite restoration**. *J Prosthet Dent. 2002 Sep;88(3):297-301. Evid Based Dent. 2004;5(2):*45.

Statement of problem: Little information exists regarding the outcome of crown build-ups on endodontically treated teeth restored with metal-ceramic crowns or with only a direct-placed composite. **Purpose:** The aim of this study was to evaluate the clinical success rate of endodontically treated premolars restored with fiber posts and direct composite restorations and compare that treatment with a similar treatment of full-coverage with metal-ceramic crowns. **Methods:** Subjects included in this study had one maxillary or mandibular premolar for which endodontic treatment and crown build up was indicated and met specific inclusion/exclusion criteria. Only premolars with Class II carious lesions and preserved cusp structure were included. Subjects were randomly assigned to 1 of the following 2 experimental groups: (1) teeth endodontically treated and restored with adhesive techniques and composite or (2) teeth endodontically treated, restored with adhesive techniques and composite, and then restored with full-coverage metal-ceramic crowns. Sixty teeth were included in the first group and 57 in the second. All restorations were performed by one operator. Causes of failure were categorized as root fracture, post fracture, post decementation, clinical and/or radiographic evidence of marginal gap between tooth and restoration, and clinical and/or radiographic evidence of secondary caries contiguous with restoration margins. Subjects were examined for the listed clinical and radiographic causes of failure by 2 calibrated examiners at intervals of 1, 2, and 3 years. Exact 95% confidence intervals for the difference between the 2 experimental groups were calculated. **Results**: At the 1-year recall, no failures were reported. The only failure modes observed at 2 and 3 years were decementations of posts and clinical and/or radiographic evidence of marginal gap between tooth and restoration. There was no difference in the failure frequencies of the 2 groups (95% confidence interval, -17.5 to 12.6). There was no difference between the number of failures caused by post decementations and the presence of marginal gaps observed in the 2 groups (95% confidence intervals, -9.7 to 16.2 and -17.8 to 9.27**). Conclusion**: Within the limitations of this study, the results upheld the research hypothesis that the clinical success rates of endodontically treated premolars restored with fiber posts and direct composite restorations after 3 years of service were equivalent to a similar treatment of full coverage with metal-ceramic crowns

Mannocci, F, Qualtrough, AJ, Worthington, HV, Watson, TF, Pitt Ford. TR. **Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fiber posts and resin composite: five-year results**. *Oper Dent. 2005 Jan-Feb;30(1):9-15, Comment: J Evid Based Dent Pract. 2006 Jun;6(2):176-7.*

Prospective clinical studies comparing the results of different types of restorations of endodontically treated teeth are lacking. This study compared the clinical success rate of endodontically treated premolars restored with fiber posts and direct composite to the restorations of premolars using amalgam. Premolars with Class II carious lesions were selected and randomly assigned to one of two experimental groups: (1) restoration with amalgam or (2) restoration with fiber posts and composite. One hundred and nine teeth were included in Group 1 and 110 in Group 2. Patients were recalled after 1, 3 and 5 years. No statistically significant difference was found between the proportion of failed teeth in the two experimental groups. Significant differences were observed between the proportion of root fractures (p=0.029) and caries (p=0.047), with more root fractures and less caries observed in the teeth restored with amalgam at the five-year recall. **Conclusions:** Within the limits of this study, it can be concluded that restorations with fiber posts and composite were found to be more effective than amalgam in preventing root fractures but less effective in preventing secondary caries.

Mehta, SB, Millar, BJ. **A comparison of the survival of fibre posts cemented with two different composite resin systems**. *Br Dent J. 2008 Dec 13;205(11):E23. Epub 2008 Nov 21.*

Objectives: To evaluate the outcomes of a fibre post cemented with two different luting agents. **Methods**: A single type of tooth coloured fibre post (Fibre-White Parapost, Coltene Whaledent) was used along with two different types of luting cement. A total of 129 teeth were treated in this retrospective audit: 79 treated were luted with Calibra Aesthetic Dental Resin Cement (Dentsply) and 50 with Panavia F 2.0 (Kuraray). All teeth were treated by the same operator and had a minimum ferrule of 2 mm and a Para-Core (Coltene Whaledent) composite core placed over the post. Where Calibra Aesthetic Dental Resin Cement was used, all the restorations were undertaken between June 2002 and October 2003 and were reviewed for a period of 38 to 54 months. Where Panavia had been used, all restorations were placed between February 2004 and December 2005 and reviewed for a period of 28 to 50 months. **Results:** The results for the Calibra cemented posts were: 64 returned for recall and of these 23 were classed as

failed. The causes were: root fracture (2), decementation (3), fracture at post-core interface (6), endodontic failure (8) and marginal caries (4). The results for the Panavia cemented posts were: 44 returned for recall and 9 were classed as failed; the causes of failure were fracture at post-core interface (6), endodontic failure (1) and marginal caries (2). **Conclusions:** For posts cemented with Calibra, a success rate of 64.1% was determined over a period of 38 to 54 months. The use of Panavia resulted in fewer post failures with a reported success rate of 79.5% over an evaluation period of 28 to 50 months. Mechanical failures by means of fractures occurring anywhere along the length of the post-core complex were the major cause of lack of success. Significantly higher failure rates were observed to occur in partially dentate patients, in those with parafunctional habits and also amongst anterior teeth. While the majority of the mechanical failures were amenable to repair, the latter mode of failure appears to be a major downfall when considering the routine use of fibre resin posts in restorative dentistry. The choice of cement appears to have a significant role in improving prognostic outcome.

*Monticelli, F., Grandini, S., Goracci, C., Ferrari, M. **Clinical behavior of translucent fiber posts: a 2-year prospective study.** *Int. J Prosthodont 2003; 16:593-596*

Purpose: This study prospectively evaluated the clinical performance of three types of translucent posts over a follow-up period of between 2 and 3 years. **Methods:** Selected were 225 patients with one premolar in need of endodontic treatment, followed by restoration with a fiber post and porcelain crown. The sample was randomly divided into three groups of 75 patients each. The same type of post was used in all patients within the group: Group 1=Aestheti-Plus posts (RTD), Group 2= D. T. Light-Post (RTD, St Egreve, France), and Group 3= FRC Postec (Vivadent / Ivoclar). For bonding the posts, a light-cure adhesive (One-Step; Bisco Dental) and a dual-curing resin cement (Duo-Link; Bisco Dental) were applied in Groups 1 and 2, whereas self-curing materials ExciteDSC adhesive (Vivadent/ Ivoclar) and MultiLink resin cement (Vivadent / Ivoclar) were used with Group 3. After 6, 12 and 24 months, patients were recalled, and a clinical and radiographic examination was performed. For some patients, 30-month follow-up data were also collected. **Results:** Debonding of the post occurred in eight cases (3.5%); in another six cases, a recurrence of the periapical lesion was reported. **Conclusion:** The statistical analysis did not reveal any significant difference in the survival rate of the tested posts, suggesting that all are equally and sufficiently reliable for clinical use. **PDF**

Monticelli, F., Ferrari, M. **Coronal residual structure affects the four-year survival of root-treated premolars.** *J Dent Res.Vol 92 (Spec Iss A) Abstract #3108, 2013 (www.dentalresearch.org)*

Objective: To assess whether the amount of residual coronal structure and the placement of a prefabricated fiber posts luted with a self-adhesive cement or a composite core material may affect the four-year survival of root filled premolars. **Method:** A sample of 120 patients provided 2 cohorts of 60 premolars needing endodontic treatment. Cohorts were defined depending on the amount of residual coronal dentin after abutment build-up and final preparation: Group A: more than 50% of coronal residual structure and at least 2 sound residual walls; Group B: less than 50% of coronal residual structure and less than 2 sound residual walls. However, at least one residual wall and a 1.5 mm ferrule was present. Teeth were randomly divided into two Subgroups (n=30) accordingly to the material used for luting posts. In Subgroup 1 a core material, (Gradia Core, GC Co., Tokyo, Japan, CM) was used, while in Subgroups 2 posts were luted using a self-adhesive cement (GCem, GC Co., SAC). Teeth were finally restored with single unit metal-ceramic crowns. **Result:** Data were not affected by any loss to follow-up. The presence of more than 50% of coronal residual structure was a significant factor for survival ($p<0.05$). The highest 48-months survival rate of crowned endodontically treated premolars was 90.0% for fiber posts luted with CM and with more than 50% of residual coronal structure. The lowest survival rate was recorded for fiber posts luted with SAC on abutments with less than 50% of coronal residual structure (73.3%). Clinical failure was mainly due to loss of retention, post debonding or crown dislodgement. **Conclusion**: The amount of residual coronal structure affects the four-year survival of filled premolars. The highest clinical success rate may be achieved when luting fiber posts with a core material on abutments with more than 50% of residual coronal structure.

Naumann, M, Blankenstein, F, Dietrich, T. **Survival of glass fibre reinforced composite post restorations after 2 years-an observational clinical study.** *J Dent. 2005 Apr;33(4):305-12.*

Objectives: The aim of this study is to provide prospective clinical data for the survival of postendodontic reconstructions of teeth with varying degrees of hard tissue loss using tapered or parallel-sided post shapes. **Methods:** Eighty-three patients got 105 glass fibre reinforced posts of tapered (Luscent Anchors, Dentatus, Glassix, Sweden) and parallel-sided, serrated (FibreKor, Jeneric Pentron, USA) post shape. A dual curing hybrid composite Compolute (3M ESPE, Germany) was used as luting material, EBS-Multi (3M ESPE) as adhesive system and Clearfil Core (Kuraray, Japan) for core built-up. The restorations were followed for a minimum of 24 months. The statistical analysis was performed on a random sub-sample of one restoration per subject. The Fisher exact test was used to compare frequencies of failures after 12 and 24 month. A Kaplan-Meier-analysis was used to analyse time-to-failure in both groups. Differences of survival time between post types were tested with the log-rank test. **Result:** 3.8% of the restorations failed after 12 month, 12.8% after 24 month, respectively. The main failure type observed was post fractures. All but one failed teeth could be restored. There was no difference in failure frequency between post types after 12 or 24 months. The log-rank test showed no differences in survival between the two types of post ($p=0.37$). **Conclusion:** Parallel-sided and tapered glass fibre posts result after 2 years of clinical service in an equal rate of survival.

Naumann, M., Reich, S., Nothdurft, F., Beuer, F., Schirrmeister, J., Dietrich, T. **Survival of glass fiber posts restorations over 5 years.** *Am J Dent; 21:267-272.*

Purpose: To evaluate the survival of glass fiber reinforced composite post (GFP) restorations and to identify risk factors for restoration failure. **Methods:** GFPs of three consecutively placed post systems, two tapered and one parallel-sided, were adhesively luted and the core was built with a resin composite. Teeth served as abutment teeth according to the prosthetic treatment plan. 149 GFP in 121 patients (age: 53 +/- 15 year; 50 men; 71 women) were followed for 5-79 months (mean +/- SD: 50 +/- 21 months). Cox proportional hazards models were used to evaluate the association between several clinical variables and the failure rate. **Results:** After exclusion of endodontic failures (n = 3), significantly higher failure rates were found for restorations of anterior teeth compared to posterior teeth (hazard regression (HR): 2.8; 95% confidence interval (CI): 1.4; 5.8; P = 0.004). Restorations in teeth with no proximal contacts compared to at least one proximal contact, single crowns compared to fixed partial dentures and less than two remaining cavity walls had a HR of 2.4 (CI: 0.8-7.1), 2.4 (CI: 0.6-8.7), and 1.5 (CI: 0.6-3.8), respectively. However, these correlations were not statistically significant (P > 0.05). **PDF**

Naumann, M, Koelpin, M, Beuer, F, Meyer-Lueckel, H. **Ten-year survival evaluation for glass-fiber-supported postendodontic restoration: a prospective observational clinical study**. *J Endod. 2012 Apr;38(4):432-5. Epub 2012 Feb 16.*

Introduction: Glass-fiber-reinforced endodontic posts (GFRPs), in combination with composite resin core materials, are commonly used to build up damaged endodontically treated teeth. However, long-term clinical data are scarce. Thus, the aim of this investigation was to evaluate the survival of 3 different GFRP systems, taking into account several other relevant factors. **Methods:** One-hundred forty-nine GFRPs in 122 patients were followed for up to 120 months. GFRPs were adhesively luted using the etch-and-rinse technique. The core was built with a chemically curing composite resin and restored according to the specific prosthetic treatment plan. Cox proportional hazards models were used to evaluate the association between clinical variables and the time until failure**. Results**: Within 10 years, 55 failures could be observed (annual failure rate = 4.6%) with the most frequent ones being post fracture, loss of post retention (both n = 17), endodontic problems (n = 7), and those resulting in tooth extraction (n = 10). Sixty posts could be followed up for 105 to 120 months (34 posts lost to follow-up, [mean (standard deviation) survival time: 74 (43) months]). In crude analyses, only the tooth type in favor of posterior teeth compared with anterior teeth and the number of remaining cavity walls (in favor of ≥ 1 compared with no wall) were significantly associated with the failure rate. Cox regression analysis revealed a significant hazard ratio of 2.0 (95% confidence interval, 1.1-3.5; P = .021) for tooth type in favor of posterior teeth. **Conclusions:** The relatively high annual failure rate of GFRPs highlights that the treatment decision should take into account the most relevant factors as tooth type and the number of remaining cavity walls.

Naumann, M, Sterzenbac, G, Alexandra, F, Dietrich, T. **Randomized controlled clinical pilot trial of titanium vs. glass fiber prefabricated posts: preliminary results after up to 3 years**. *Int J Prosthodont. 2007 Sep-Oct;20(5):499-503.*

Purpose: This randomized parallel-group clinical pilot study aimed to compare the clinical outcome of prefabricated rigid titanium to glass fiber endodontic posts when luted with self-adhesive universal resin cement. **Methods:** Ninety-eight patients in need of postendodontic restoration were assessed for eligibility. Ninety-one patients met the selection criteria and were randomized and allocated to 2 intervention groups. Forty-five participants were treated using a titanium post and 46 participants received a glass fiber post, each in combination with composite core buildups for postendodontic restoration. All posts had a diameter of 1.4 mm and a length of 13 mm and were cemented 8 mm within the root canal with self-adhesive universal resin cement. A circumferential ferrule of 2 mm was always provided. Surgical crown lengthening was necessary in 13 cases. Patients were observed in intervals of 3, 6, 12, 24, and 36 months after post placement. **Results:** After 24 to 36 months (mean +/- SD: 27.9 +/- 5.6) of observation following post placement, 1 tooth was extracted because of changes of the prosthetic treatment plan. No failures were observed among the 88 patients with follow-up data. **Conclusions**: Both titanium and glass fiber reinforced composite posts result in successful treatment outcomes after 2 years. The material combination used seems to be appropriate in the short term for cementing endodontic posts, irrespective of the post material.

*Parisi, C, Valandro, LF, Ciocca, L, Gatto, MR, Baldissara, P. **Clinical outcomes and success rates of quartz fiber post restorations: A retrospective study.** *J Prosthet Dent. 2015 May 23. pii: S0022-3913(15)00148-1. doi: 10.1016/j.prosdent.2015.03.011. [Epub ahead of print]*

Statement of Problem: Cast metal posts and dowels are inherently dark and, when metal-free restorations are used, could impair the definitive esthetic appearance. Quartz fiber posts could represent a reliable choice for restoring abutment teeth. PURPOSE: The purpose of this study was to evaluate the long-term success rate of teeth restored with quartz fiber posts and fixed dental prostheses (FDPs). **Methods:** Ninety-nine teeth restored with 114 quartz fiber posts and FDPs were evaluated. The evaluation time ranged from 7 months to 9.25 years. The Kaplan-Meier method was used to obtain success curves. The influence of the tooth location, definitive restoration, and failure pattern upon the success function was analyzed with the log-rank test. The Cox regression test was used to evaluate possible predictors among the interactions of the observed parameters. **Results:** The success rate of the restorations was 85.86% in a mean period of 5.88 ±1.37 years, with an estimated success probability of 85% at 6.17 years. The statistical analysis identified the factors related to the arch (P=.045) and type of definitive restoration (P=.021) as significantly associated with success. Post debonding was the most frequent failure mode, followed by endodontic failure, with the latter not necessarily being related to the post itself. No root fractures were recorded. Twelve teeth out of the 14 that failed were restored

again, bringing the overall survival rate of the teeth to 98%. **Conclusions:** The rehabilitation of abutment teeth with quartz fiber posts can be considered a reliable procedure; however, adhesive techniques and luting materials require improvement. **PDF**

Preethi, G, Kala, M. **Clinical evaluation of carbon fiber reinforced endodontic post, glass fiber reinforced post with cast post and core: A one year comparative clinical study**. *J Conserv Dent. 2008 Oct;11(4):162-7*

Aim: Restoring endodontically treated teeth is one of the major treatments provided by the dental practitioner. Selection and proper use of restorative materials continues to be a source of frustration for many clinicians. There is controversy surrounding the most suitable choice of restorative material and the placement method that will result in the highest probability of successful treatment. This clinical study compares two different varieties of fiber posts and one cast post and core in terms of mobility of crown margin under finger pressure, recurrent caries detected at the crown margin, fracture of the restoration, fracture of the root and periapical and periodontal pathology requiring crown removal over the period of 12 months as evaluated by clinical and radiographical examination. **Methods**: 30 root canal treated, single rooted maxillary anterior teeth of 25 patients in the age range of 18-60 years where a post retained crown was indicated were selected for the study between January 2007 and August 2007; and prepared in a standard clinical manner. It was divided into 3 groups of 10 teeth in each group. After post space preparation, the Carbon fiber and Glass fiber reinforced posts were cemented with Scotch bond multipurpose plus bonding agent and RelyX adhesive resin cement in the first and second groups respectively. The Cast post and cores were cemented with Zinc Phosphate cement in the third group. Following post- cementation, the preparation was further refined and a rubber base impression was taken for metal-ceramic crowns which was cemented with Zinc Phosphate cement. A baseline periapical radiograph was taken once each crown was cemented. All patients were evaluated after one week (baseline), 3 months, 6 months and one year for following characteristics mobility of crown margin under finger pressure, recurrent caries detected at the crown margin, fracture of the restoration, fracture of the root and periapical and periodontal pathology. R**esults**: Results after 12 months showed that none of the restorations among groups of cast post and core, carbon fiber reinforced post and glass fiber reinforced post with composite core restorations failed in terms of recurrent caries detected at the crown margin, fracture of the restoration, fracture of the root and periapical and periodontal pathology. One case of cast post and core and one case of carbon fiber reinforced post with composite core restorations showed slight mobility of crown margin under finger pressure at 12(th) month recall but all the cases of glass fiber post with composite core restorations did not show any signs of mobility of crown margin under finger pressure at all the recall periods on clinical and radiographical examination. **Conclusion:** From this 12 months clinical evaluation of all the cases in the 3 groups comprising of cast post and core; carbon fiber reinforced post with composite core and glass fiber reinforced post with composite core restored with porcelain fused to metal crowns, it is concluded that glass fiber reinforced post with composite core when used in single rooted upper anterior teeth are associated with a higher success rate in restoration of endodontically treated teeth. **PDF**

Salvi, GE, Siegrist Guldener, BE, Amstad, T, Joss, A, Lang, NP. **Clinical evaluation of root filled teeth restored with or without post-and-core systems in a specialist practice setting.** *Int Endod J. 2007 Mar;40(3):209-15.*

Aim: To assess survival rates and complications of root-filled teeth restored with or without post-and-core systems over a mean observation period of >or=4 years. **Methodology:** A total of 325 single- and multi-rooted teeth in 183 subjects treated in a private practice were root filled and restored with either a cast post-and-core or with a prefabricated titanium post and composite core. Root-filled teeth without post-retained restorations served as controls. The restored teeth served as abutments for single unit metal-ceramic or composite crowns or fixed bridges. Teeth supporting cantilever bridges, over-dentures or telescopic crowns were excluded. **Results:** Seventeen teeth in 17 subjects were lost to follow-up (17/325: 5.2%). The mean observation period was 5.2 +/- 1.8 (SD) years for restorations with titanium posts, 6.2 +/- 2.0 (SD) years for cast post-and-cores and 4.4 +/- 1.7 (SD) years for teeth without posts. Overall, 54% of build-ups included the incorporation of a titanium post and 26.5% the cementation of a cast post-and-core. The remaining 19.5% of the teeth were restored without intra-radicular retention. The adjusted 5-year tooth survival rate amounted to 92.5% for teeth restored with titanium posts, to 97.1% for teeth restored with cast post-and-cores and to 94.3% for teeth without post restorations, respectively. The most frequent complications included root fracture (6.2%), recurrent caries (1.9%), post-treatment peri-radicular disease (1.6%) and loss of retention (1.3%). **Conclusions:** Provided that high-quality root canal treatment and restorative protocols are implemented, high survival and low complication rates of single- and multi-rooted root-filled teeth used as abutments for fixed restorations can be expected after a mean observation period of > or =4 years.

Sarkis-Onofre, R, Jacinto, RD, Boscato, N, Cenci, MS, Pereira-Cenci, T. **Cast metal vs. glass fibre posts: A randomized controlled trial with up to 3 years of follow up.** *J Dent. 2014 Feb 12. pii: S0300-5712(14)00042-6. doi: 10.1016/j.jdent.2014.02.003. [Epub ahead of print]*

Objective: This randomized controlled trial compared the survival of glass fibre and cast metal dental posts used to restore endodontically treated teeth with no remaining coronal wall. **Methods:** Fifty-four participants (45 women) and 72 teeth were evaluated during a follow-up period of up to 3 years. Teeth were randomly allocated to the glass-fibre and cast-metal post groups. All teeth were restored with single metal-ceramic crowns. Survival probabilities were analyzed using Kaplan-Meier statistics ($p \leq 0.05$). **Results:** The 3-year recall rate was 92.3% and the survival rates of glass fibre and cast metal posts were similar (97.1% and 91.9%, respectively; $p=0.682$). Four failures were observed: two glass fibre posts in a premolar and anterior tooth de-bonded, one glass fibre post in a premolar de-bonded in association with

root fracture, and one root fracture occurred in a molar with a cast metal post. **Conclusion:** Glass fibre and cast metal posts showed similar clinical performance in teeth with no remaining coronal wall after 3 years. **Clinical significance:** Posts are used to restore most endodontically treated teeth with no remaining coronal wall. This randomized controlled trial, one of few to compare glass fibre and cast metal posts in such teeth, showed that post type did not significantly influence the survival of restorations. These results can help dentists respond to the important question of how best to rehabilitate endodontically treated teeth with no remaining coronal wall.

Schmitter, M, Hamadi, K, Rammelsberg, P. **Survival of two post systems--five-year results of a randomized clinical trial.** *Quintessence Int. 2011 Nov-Dec;42(10):843-50.*

Objectives: To assess the survival rate of two different post systems after 5 years of service with a prospective randomized controlled trial. **Methods:** One hundred patients in need of a post were studied. Half of the patients received long glass fiber-reinforced posts, while the other half received long metal screw posts. The posts were assigned randomly. After at least 5 years (mean, 61.37 months), follow-ups were established. When a complication occurred prior to this recall, the type and time of the complication was documented. Statistical analysis was performed using the log-rank test and Kaplan-Meier analysis. Additionally, a Cox regression was performed to analyze risk factors. **Results:** The survival rate of fiber-reinforced posts was 71.8%. In the metal screw post group, the survival rate was significantly lower, 50.0% (log-rank test, P = .026). Metal posts resulted more often in more unfavorable complications (eg, root fractures); consequently, more teeth (n = 17) had to be extracted. The Cox regression identified the following risk factors: position of the tooth (anterior vs posterior teeth), degree of coronal tooth destruction, and the post system (fiber-reinforced post vs metal screw post). Fiber-reinforced restorations loosened in several patients; in some of these cases (n = 6), patients did not notice this, leading to the extraction of teeth. **Conclusions:** Long metal screw posts should be used with great care in endodontically treated teeth. Besides the selection of the post system, other factors influence the survival of the restoration.

Scotti,,R., Malferrari, S., Monaco, C**.. Clinical evaluation of quartz fiber posts: 30 months results.** *J Dent Res. 81 IADR Abstract #2657; 2002 (www.dentalresearch.org)*

The usage of the aesthetic fibre posts is progressively growing for their promising clinical performances and their good aesthetic characteristics. **Objectives:** the aim of this 30 months in vivo study is to evaluate the clinical success-rate of 180 endodontically treated teeth, restored by the usage of "white" quartz fiber post and finalized with the metal-ceramic crowns and all–ceramic crowns. **Methods:** all the teeth were endodontically treated according to the recent techniques. In accordance with the international literature, to achieve clinical information, parameters were recorded in diagrams. Posts used were Aestheti-Plus (RDT, St. Egréve, France) in combination with All-Bond 2 adhesive resin (Bisco, Schaumburg, IL, USA) and C&B Resin Cement (Bisco, Schaumburg, IL, USA), the build up of the core was performed with the composite material Core-Flo (Bisco, Schaumburg, IL, USA), or Bis-Core (Bisco, Schaumburg, IL, USA). The post and core restorations were evaluated after 2 weeks, 1, 3, 6, 12, 20 (Malferrari et al., IADR abstr #11; Rome 2001) and 30 months, recording the surviving rate. **Results:** three failures were observed, one was a cohesive fracture that occurred after two weeks, involving a margin of the composite restoration and two were adhesive fractures, that occurred after a a couple of months, both located at the interface cement and dentinal walls of the canal. As all the failures occurred during removing the temporary it was possible to replace the restorations, that are still in place up to the present day. The 3 failures that occurred during this period do not show any relevance according to the statistical analysis with the Chi Square test (p=0.246). **Conclusions:** according to these results, and considering the limits of this study, the quartz posts, within a 30 months period of rehabilitation of endodontically treated teeth, clinically performed with success.

Scotti, N, Eruli, C, Comba, A, Paolino, DS, Alovisi, M, Pasqualini, D, Berutti, E. **Longevity of class 2 direct restorations in root-filled teeth: A retrospective clinical stud**y. *J Dent. 2015 May;43(5):499-505. doi: 10.1016/j.jdent.2015.02.006. Epub 2015 Feb 17.*

Objectives: To evaluate retrospectively the longevity of endodontically treated teeth restored with direct resin composite without cusp coverage, with or without the insertion of fibre posts. The null hypothesis was that direct restorations with fibre posts perform better than those without fibre posts. **Methods:** Patients recruited for this study were treated in the Department of Cariology and Operative Dentistry, University of Turin, between 2008 and 2011. In total, 247 patients with 376 root treated posterior teeth, restored with direct resin composite, were recalled for a control visit. Only second-class cavities were considered. Two groups were defined based on the absence (Group A) or presence (Group B) of fibre post. Failures and complications, such as periodontal failure, endodontic failure, tooth extraction, root fracture, post fracture, post debonding, replacement of restoration, crown displacement, and coronal-tooth fracture, were noted. Functional restoration quality was evaluated following the modified USPHS criteria. Data were evaluated statistically with ANOVA. **Results:** Group A consisted of 128 patients with 178 restorations (88 premolars, 90 molars) with a median follow-up of 34.44 months. Group B consisted of 119 patients with 198 teeth (92 premolars, 106 molars) with a median follow-up of 35.37 months. Direct restorations with fibre posts were statistically significantly more functional (95.12% success) than those without fibre posts (80% success) because of less marginal discolouration, better marginal integrity, and higher restoration integrity. **Conclusions:**The null hypothesis was accepted because direct post-endodontic restorations with fibre posts performed better than restorations without posts after 3 years of masticatory function. **Clinical significance:** An evaluation of the longevity of post endodontic direct restoration would seem to enhance the fiber post insertion within a composite restoration to reduce clinical failures.

Signore, A, Kaitsas, V, Ravera, G, Angiero, F, Benedicenti, S. **Clinical evaluation of an oval-shaped prefabricated glass fiber post in endodontically treated premolars presenting an oval root canal cross-section: a retrospective cohort study**. *Int J Prosthodont. 2011 May-Jun;24(3):255-63.*

Purpose: This retrospective cohort study investigated the clinical effectiveness of preformed oval-shaped glass fiber posts in combination with a dual-curing composite resin core material in endodontically treated premolars presenting an oval root canal cross-section and restored with all-ceramic crowns over up to 45 months. **Methods:** The study population comprised 134 patients and 154 endodontically treated premolars, with varying degrees of hard tissue loss, restored by means of oval-shaped fiber-reinforced posts. Inclusion criteria were premolars presenting an oval-shaped root canal, symptom-free endodontic therapy, root canal treatment with a minimum apical seal of 4 mm, application of rubber dam, and the need for a post and core complex because of coronal tooth loss. Four groups were defined based on the number of preserved coronal walls after endodontic treatment and before core buildup. Survival rate of the post and core restorations was determined using Kaplan-Meier analysis, and statistical analysis was performed using the log-rank test ($P < .05$). **Results:** The posts and cores were examined clinically and radiographically. The mean observation period was 42.3 ± 2.7 months. The overall survival rate was 95.45%. Comparisons revealed that the difference between premolars with no coronal wall retention and premolars that had maintained one to four coronal walls was statistically significant ($P = .0006$). On the contrary, comparison between premolars with one and two residual walls was found to be not significant for the overall survival rate ($P = .0698$). **Conclusion:** A satisfactory clinical performance was observed for preformed oval-shaped glass fiber posts. Survival was higher for teeth retaining three and four coronal walls.

Signore, A., Benedicenti, S., Kaitsas, V., Barone, M., Angiero, F., Ravera, G. **Long-term survival of endodontically treated, maxillary anterior teeth restored with either tapered or parallel-sided glass-fiber posts and full-ceramic crown coverage.** *J Dent. 2008 Dec 15. [Epub ahead of print]*

Objectives: This retrospective study investigated the clinical effectiveness over up to 8 years of parallel-sided and of tapered glass-fiber posts, in combination with either hybrid composite or dual-cure composite resin core material, in endodontically treated, maxillary anterior teeth covered with full-ceramic crowns. **Methods:** The study population comprised 192 patients and 526 endodontically treated teeth, with various degrees of hard-tissue loss, restored by the post-and-core technique. Four groups were defined based on post shape and core build-up materials, and within each group post-and-core restorations were assigned randomly with respect to root morphology. Inclusion criteria were symptom-free endodontic therapy, root-canal treatment with a minimum apical seal of 4mm, application of rubber dam, need for post-and-core complex because of coronal tooth loss, and tooth with at least one residual coronal wall. Survival rate of the post-and-core restorations was determined using Kaplan-Meier statistical analysis. **Results:** The restorations were examined clinically and radiologically; mean observation period was 5.3 years. The overall survival rate of glass-fiber post-and-core restorations was 98.5%. The survival rate for parallel-sided posts was 98.6% and for tapered posts was 96.8%. Survival rates for core build-up materials were 100% for dual-cure composite and 96.8% for hybrid light-cure composite. **Conclusions:** For both glass-fiber post designs and for both core build-up materials, clinical performance was satisfactory. Survival was higher for teeth retaining four and three coronal walls.

Subramaniam, P, Babu, KL, Sunny, R. **Glass fiber reinforced composite resin as an intracanal post--a clinical study.** *J Clin Pediatr Dent. 2008 Spring;32(3):207-10.*

Restoration of primary incisors, which have been severely damaged by early childhood caries or trauma, is a difficult task for the pediatric dentist. With the introduction of new adhesive systems and restorative materials, alternative approaches for treating these teeth have been proposed. **Materials:** Ten healthy children aged between 3-4 years who had 28 grossly destructed primary maxillary incisors requiring intra canal retention were selected for the study. Following root canal treatment, either a Glass Fiber Reinforced Composite Resin (GFRCR everStick,, Finland) or an omega shaped stainless steel wire were placed as intracanal posts in these teeth. Flowable composite was used for cementation of posts and also to build up the coronal structure using celluloid strip crowns. Both types of intracanal posts were evaluated for retention and marginal adaptation at 1, 6 and 12 months. The data obtained was subjected to statistical analysis. **Conclusion**: GFRCR intracanal posts showed better retention and marginal adaptation than omega shaped stainless steel wire posts.

VI. Post Removal

*Anderson, G. Jorge Perdigao, J., Hodges, J., Bowles, W. **Efficiency and effectiveness of fiber post removal using 3 techniques.** *Quintessence Int 2007; 38:663–670*

Objective: To evaluate the speed (efficiency) and effectiveness of 3 different fiber post removal systems. **Methods:** Fiber posts (D.T. Light-Post Size no. 1 (RTD St Egreve, France /Bisco Dental) and ParaPost FiberLux no. 5 (Coltène/Whaledent) were cemented into 60 single-rooted teeth after endodontic therapy and post space preparation were completed. Three methods of fiber post removal were evaluated—D.T. Light-Post removal kit, the Kodex twist/Tenax ParaPost fiber post removal drill kit, and a combination of diamond bur/Peeso reamer. **Results:** The efficiency to remove either fiber post was not significantly different, nor

post types, but effectiveness was higher with the diamond bur/Peeso reamer compared with the Kodex twist/Tenax ParaPost drills, which in turn was more effective than the D.T. Light-Post removal kit. **Conclusions:** Fiber posts are efficiently removed by all 3 methods, but effectiveness of removal is higher using the diamond bur/Peeso reamer.

*Aydemir. S, Arukaslan. G, Sarıdağ. S, **Comparing fracture resistance and the time required for two different fiber post removal systems.** *J Prosthodont. 2017 Jan 9. doi: 10.1111/jopr.12575. [Epub ahead of print]*

Purpose: To compare two fiber post removal techniques in terms of fracture resistance and time required for post removal. **Methods:** Post space was prepared to a 9-mm depth in each root canal. The roots were randomly divided into three groups of 15 specimens each. D.T. Light-Posts were cemented in all groups. In group 1, fiber posts were removed using the **D.T. Light-Post-**removal kit; in group 2, Start-X stainless-steel ultrasonic tips were used. In group 3, fiber posts were left without removal (the control group). For all groups, fracture resistance (N) value was measured and recorded using a universal testing machine. Times required for fiber post removal were also recorded for the two study groups. **Results:** There was no significant difference between the control and removal kit groups for fracture resistance values ($p = 0.233$). The fracture resistance value of the ultrasonic group was found to be significantly lower than that of the control group ($p = 0.001$) as well as that of the removal kit group ($p = 0.032$). The fiber post removal time for the ultrasonic group was significantly longer than that for the removal kit group ($p < 0.001$). **Conclusion**: Compared to the removal kit, removal of the fiber posts with an ultrasonic tip decreases the fracture resistance of the roots, although significantly more time is required.

*Baldissara, P., Valandro, L.F., Bettazonni, S., Scotti, R. **Tissue loss during post removal; A new post concept evaluation.** *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #772, 2010 (www.dentalresearch.org)*

Objectives: to evaluate the tissue loss and tooth damages during fiber post removal. Clear colored fiber post removal is a challenging task due to the low color contrast with restorative materials and dentin. **Methods:** 40 human single-rooted teeth were treated endodontically and randomly assigned to four fiber posts groups restored with: 1) Premier90 (Innotech); 2) DT#2 Light-Post (RTD / Dentsply); 3) Unicore#3 (Ultradent); 4)a special, soft-cored "S" glass fiber post Hi-Rem Prosthetic#3 (Overfibers). An impression of the canal was taken prior post cementation. The posts were luted with Panavia F system (Kuraray). The specimens were mounted in a dental training manikin to reproduce the clinical conditions. The posts were removed using a diamond bur/Gates and Largo combination by postgraduate students. Cement and post remains were removed using an ultrasonic tip (Suprasson P5 Newtron, Satelec, France). The teeth were examined radiographycally 2 times seeking for cement, fiber composite debris and tooth damage. After post and cement complete removal, another PVSS impression (Elite HD, Zhermack) of the canal was taken to evaluate the canal enlargement, which was recorded by laser scanning of the impressions and calculated using 3D reverse engineering software (OpenScan). Then, the specimens were externally and internally (after fracturing) observed under the stereomicroscope. **Results:** among groups 1 to 3, dental tissue losses were not significantly different (Kruskal-Wallis and Dunn, $p>.05$). These groups showed 3 root perforations each and canal stripping in 18 cases. The canal enlargement was significantly lower in group 4) Hi-Rem Prosthetic posts ($p<.05$); no perforations or canal stripping occurred in this group. **Conclusion:** removal of posts avoiding dental tissue loss is a difficult task when performed in simulated clinical conditions. A new fiber post type Hi-Rem "easy removal post" conceived for safe and fast removal proved to be highly effective in dental tissue preservation when compared to conventional posts.

de Rijk, W. G. **Removal of fiber posts from endodontically treated teeth.** *American Journal of Dentistry. 13: 19B-21B, 2000.*

Abstract/conclusions: The removal of posts from endodontically treated teeth can be a major obstacle in the retreatment of teeth that have recurrent pathology, often leading to extraction of a tooth that could have been saved with endodontic retreatment. The use of a fiber post offers the advantages of a suitable elastic modulus and good bonding between post and cement, but also the advantage of easy removal, if so indicated by clinical findings. A special removal kit for fiber posts has been developed, and its use is illustrated, and described. The removal procedure can be completed in a very short time, usually less than 5 min. The tooth can then be restored with the same type and size of fiber post as was in the tooth prior to removal. Removal kits are found to be for single use only. **PDF**

Cormier, C., Burns, D., Moon, P., **In vitro comparison of the fracture resistance and failure mode of fiber, ceramic, and conventional post systems at various stages of restoration**. *J Prosthodont 2001; 10:26-36*

Abstract/ conclusions: The fiber posts evaluated provided an advantage over a conventional post that showed a higher number of irretrievable post and unrestorable root fractures. At the stage of final restoration insertion, there was no difference in force to failure for all but the FiberKor material, which continued to be weaker than all other materials tested. The fiber posts were readily retrievable after failure, whereas the remaining post systems tested were non-retrievable. **PDF**

Frazer, R.Q., Kovarik, R., Chance, K.B., Mitchell, R. **Removal times of fiber posts versus titanium posts**. *Am J Dent 2008; 21:175-178.*

Purpose: To evaluate the time needed to remove a glass reinforced fiber post versus a titanium post. **Methods:** 40 extracted anterior teeth were mounted in acrylic blocks then treated endodontically. They were randomly assigned to three groups. The teeth were sectioned horizontally, with the coronal portion removed. The fiber posts were cemented with resin cement and the titanium posts were cemented with glass ionomer or resin cement. The fiber posts were removed by coring them out internally. The titanium posts were removed by creating a trough around the post and then vibrating with ultrasonic energy. The teeth were examined visually and radiographically to ensure complete removal of the post AND cement. Removal Time included the time to make radiographs necessary to ensure complete removal. **Results:** Post-cement combination significantly affected the median rank of the removal time (Kruskal-Wallis test; H=12.709; P=0.002). The mean rank removal time of titanium posts cemented with resin cement were significantly higher that the mean rank of the other two post-cement combinations (Dunn's multiple comparison test; P=<0.05). There was no significant difference between the othertwo combinations. **Clinical Significance:** When removing a fiber post, there is no need to create a trough around the fiber post or to use ultrasonic vibration that may weaken the tooth. Th canal space can be cleaned and a new post placed, or the canal can be enlarged and additional retentive features added. **PDF**

Gesi, A., Magnolfi, S., Goracci, C., Ferrari, M. **Comparison of two techniques for removing fiber posts.** *JOE Vol. 29, No. 9, September, 2003*

Abstract/ conclusions: The purpose of this study was to evaluate the time needed to remove several types of fiber posts using two different bur kits. Estimates refer to the time needed to pass the fiber post until arriving at the gutta percha. Sixty extracted anterior teeth were treated endodontically. A post space with a standard depth of 10mm was prepared in each root canal. The sample was randomly divided into 3 groups of 20 specimens each. Three different types of posts were cemented: group 1, Conic 6% tapered fiber posts (Ghimas), group 2, FRC Postec posts (Ivoclar/Vivadent); and group 3, Composipost carbon fiber posts (RTD, St Egreve, France). To remove the posts, for half of each group's the burs for the RTD fiber post removal kit were used (subgroup A). For the other half of the teeth in each group (subgroup B) were removed by using a diamond bur and a Largo bur. Composipost (group 3) took significantly less time to remove that the other two types of posts ($p<0.05$). For the bur kits, the procedure involving the use of a diamond and a Largo bur (subgroup B) was significantly faster ($p<0.05$). The interaction between the type of post and the type of bur kit was not significant ($p>0.05$). **PDF**

Lindemann, M, Yaman, P, Dennison JB, Herrero, AA. **Comparison of the efficiency and effectiveness of various techniques for removal of fiber posts.** *J Endod. 2005 Jul;31(7):520-2*.

A study was conducted to determine the efficiency and effectiveness of several techniques for fiber post removal. Four groups of 20 mandibular premolars were endodontically treated and obturated. Post spaces were prepared for the following post systems: ParaPost XH, ParaPost Fiber White, Luscent Anchors, and Aestheti-Plus. After cementation, 10 posts of each group were removed with their corresponding manufacturer's removal kit and the other 10 removed with diamond burs and ultrasonics. Removal times were recorded and the teeth were sectioned vertically and microscopically analyzed for removal effectiveness based on a 0 to 5 point scale. Removal kits removed Luscent Anchors the fastest (mean = 3.9 min) and most effectively (mean = 2.6), while Aestheti-Plus posts were removed the slowest (mean = 7.3 min) and least effectively (mean = 3.4). Diamonds and ultrasonics required an average of 10 additional minutes for each fiber post system removal, yet removal effectiveness improved half a point. The results suggest recommended removal kits were significantly more efficient, while diamonds and ultrasonics were more effective. Removal kits could be enhanced with subsequent ultrasonic instrumentation to remove remaining fibers and cement. **PDF**

Sakkal, S., **Carbon-fiber post removal technique.** *Compendium. 17: S86-1996.*

Abstract/ conclusions: In the event of endodontic failure, removal of a metal post is a time-consuming, challenging and expensive task. The Carbon fiber post (Composipost) is the first post with a proven and safe method of retrieval that takes only a matter of minutes. Chair-time is reduced and there is less chance of harming sound tooth structure during the removal process, because the entire procedure is performed using slow speed. The removal technique is described in 6 steps. **PDF**

VII. CUSTOMIZED LOW-MODULUS RESTORATIONS

Aggarwal, V., Singla, M., Miglani, S., Kohli, S. **Comparative evaluation of fracture resistance of structurally compromised canals restored with different dowel methods.** *J Prosthodont. 2012 Jun;21(4):312-316. doi: 10.1111/j.1532-849X.2011.00827.x. Epub 2012 Feb 19.*

Purpose: The objective of this in vitro study was to evaluate and compare the fracture resistance and fracture mode of endodontically treated teeth with wide root canals restored with various dowel methods. **Methods:** Fifty human uni-radicular mandibular premolar teeth were de-coronated and endodontically-treated. The canals were widened with diamond points. The specimens were

divided into five groups on the basis of type of dowel method used: conventional custom-made cast metal dowel; single glass fiber-reinforced resin dowel; glass fiber-reinforced resin dowel with accessory fiber dowels; relined glass fiber-reinforced resin dowel; and dowels formed with the help of polyethylene fiber ribbon-reinforced resin composite. Specimens were restored with indirect composite crowns, and 150,000 cycles of cyclic loading were applied. The specimens were loaded to test the fracture resistance and fracture mode (repairable and non-repairable). **Results:** The cast metal dowel groups had the highest fracture resistance but showed non-repairable fracture in 90% of specimens. **Conclusions**: Cast metal dowels had the highest fracture resistance but led to non-repairable fracture while restoring the wide root canals under cyclic loading. Specimens restored with fiber dowels, accessory dowels, relined dowels, and ribbon-reinforced resin provided adequate fracture resistance with increased incidence of repairable fractures. **PDF**

*Alkumru, H., Akkayan, B, et al, **Fracture strength of teeth in oval-shaped root canals restored with posts and accessory post systems.** *Canadian Journal of Restorative Dentistry & Prosthodontics/— Vol. 6, No. 1 — Spring, 2013.*

In contemporary restorative dentistry, post-root canal adaptation always represents an important role in successful and long-lasting treatment for the restoration of endodontically treated teeth. In some cases posts have to be placed in wide oval-formed root canal spaces. However, the impact of the treatment outcome of the increasing non-uniform cement thickness around the posts has not yet reached a consensus. The purpose of this research is to assess the treatment outcome of post systems with three different post geometries, combined with/without accessory posts as an alternative technique in the oval-shaped canals. Seventy-two teeth with oval-shaped canals were selected for the study. Crowns were sectioned at the cemento-enamel junction and endodontically treated. The roots were randomly divided into 2 groups of 36 specimens and each group was split into 3 subgroups of 12 as follows; G1-A, Quartz fiber post with double tapered cross-section (QFibDT); G1-B, Quartz fiber post with circular cross-section (QFibCir); G1-C Quartz fiber post with oval cross-section (QFibOv); G2-A Quartz fiber post with double tapered cross-section + two accessory quartz fiber posts (QFibDTAcces); G2-B Quartz fiber post with circular cross-section + two accessory quartz fiber posts (QFibCirAcces); G2-C Quartz fiber post with oval cross-section + two accessory quartz fiber posts (QFibOvAcces). Root canal preparations were performed with low-speed Torpan Drill tips of ISO 90, ISO 100 and ISO 120 in increasing order. All posts were cemented with self-adhesive dual polymerizing resin cement. Two specimens from each group were randomly chosen upon the cementation of all posts and processed for stereomicroscope (SM) evaluation of the fiber post-cemented interface. All sixty specimens were then embedded in auto polymerizing acrylic resin surrounded by aluminum cylinders and light-polymerized composite cores were produced. Pressed all ceramic crowns were cemented on each core. Specimens were secured in a universal testing machine with the use of a device that allowed loading of the specimens lingually at 135 degrees to the long axis. A compressive force was applied at a crosshead speed of 1 mm/min until fracture occurred. The fracture loads (N) were determined and the obtained data were analyzed by 1-way ANOVA with interaction followed by Tukey HSD tests. Student's t test was used for between group comparisons. Representative stereomicroscope images and cement thickness measurements were performed on 2 mm sectioned specimens. Within-group comparisons for Group 1 specimens demonstrated statistically higher fracture strength values for groups cemented with G1-A, DT Light Post (590 N) and G1-B, Match Post (570,9 N) groups compared to G1-C, Ellipson Post group (400,83 N) ($p<.001$). The highest fracture resistance was recorded for G2-A (QFibDTAcces) at 764,18 N, followed by group G2-B (QFibCirAcces) at 726,5 N. Within-group comparisons of these two groups (G2-A, G2-B) resulted in statistically higher fracture resistance of teeth compared to G2-C (QFibOvAcces) at 574,96 N ($p<.001$). Regardless of the post system geometry tested in this study, Group 2 specimens resulted in statistically higher fracture strength values compared to Group 1 specimens according to between group comparisons ($p<.001$). No catastrophic failures were present and there were no root fractures. It can be speculated that when restoring with posts, especially in wide oval-shaped canals, the use of accessory posts reduces the cement thickness around the posts thus increasing the endodontically treated teeth resistance to fractures. **PDF**

*Akkayan, B., Gaucher, H., Atalay, S., Alkumru, H. Effect of post geometry on the resistance to fracture of endodontically treated teeth with oval-shaped root canals. *Canadian journal of restorative dentistry and prosthodontics. Summer 2010 Pages 20-26.*

Abstract: Post-root canal adaptation represents an important role in the biomechanical performance of teeth and the post-core systems. Close canal adaptation with minimal tooth structure removal provides a conservative and long-lasting treatment for the restoration of endodontically treated teeth. In some cases the root configuration could anatomically be an oval form rather than a circular shape or the resulting preparation of the canal during endodontic treatment may produce an oval form. The purpose of this study is to evaluate the effect of different fibre reinforced post systems of different geometrical cross sections, oval and circular, on the fracture resistance of endodonticallytreated teeth with oval-shaped root canals. Methods: 40 maxillary intact human canines were selected for this study. The crowns of each root were sectioned at the cemento-enamel junction.The roots were divided into 4 groups of io teeth following endodontic treatment; Quartz fibre post with oval section (0FibOv); (2) Flexible resin-impregnated glass fibre stick (GFibSti); (3) Small diameter quartz fibre post with circular section and accessory cone (0FibCirAcces); (4) Glass fibre post with circular section (GFibCir). Root canal preparations were performed with the special preparation drills provided in each system. All posts were cemented with self-adhesive dual polymerizing resin cement and light-polymerized composite cores were formed. Specimens were then embedded in auto polymerizing acrylic resin melds and secured in a universal testing machine with the use of a device that allowed loading of the specimens lingually at 135 degrees to the long axis. A compressive force was applied at a crosshead speed of 1 mm/min until fracture occurred. The fracture loads (N) were determined and the data were analyzed by 1-way ANOVA with interaction followed by Tukey HSD tests. Results: The mean failure loads (Newtons) and standard deviations (SDs) of the different post groups were calculated. The highest fracture resistance was recorded for group 3 teeth (0FibCirAcces) at 635.6 N; followed by group 1 (0FibOv); group 4 (GFibCir); and group 2 (GFibSti) at 488.4 N, 449.3 N, and 314.8 N respectively. Between-group differences in the fracture resistance of teeth were significant ($p < 001$) except for groups 1 and 4 (p

>.o5). Teeth in all 4 experimental groups displayed favourable fractures. No catastrophic failures were present and there were no root fractures. All fractures displayed favourable, repairable modes. Conclusions: It can be speculated that cross-sectional similarity between the root canal configuration and the geometric form of the pre- fabricated post system is an effective variable on the fracture resistance of endodontically treated teeth. Using accessory posts to fill the post space and decrease the cement layer thickness may result in higher values. **PDF**

Ariki, E.K, , Gonçalves, M, Souza, ROA, Z , S.C.,Gia, PEL, Takahashi, F.E., Bottino, M.A, **Resin bond to root dentin: Accessory posts and dentin hybridization effect.** *J Dent Res. Vol 87 (Spec. Iss. A) Abstract 1748 (www.dentalresearch.org)*

Objective: To evaluate the influence of accessory fiber posts (AFP) and intra-radicular dentin hybridization (IDH) on the push-out bond strength of fiber post luted with resin cement to bovine root dentin. The null hypotheses were that the AFP using and IDH do not affect the push-out bond strength. **Methods:** The canals of forty single-root bovine roots (16mm in length) were prepared at 12mm using the preparation drill (N0 3, RTD, France). With an assistance of a modifier parallelometer, each root had your apical region (4 mm length) embedded in acrylic resin and the roots were randomly divided into four groups, according the luting procedures (N=10): Gr1- IDH + fiber post n0 3; Gr2- IDH + fiber post n0 1; Gr3- IDH + fiber post n0 1 + AFP; Gr4- Fiber post n0 3 without IDH. Except for the group Gr4, the specimens (sps) were treated with the adhesive system (All Bond 2) and the fiber posts (Macro- Lock Illusion) were luted (Duo-Link) and after stored in distilled water prior the mechanical test (24 h, 37°C). Each specimen was cut in 4 disc samples (1.8 mm in thickness), which were submitted to the push-out test on a universal test machine (EMIC, model DL-1000) at a speed of 1mm/min. The data (MPa) were analyzed statistically by one-way analysis of variance (ANOVA). **Results:** The means (± standard deviation) values obtained after push out test were: Gr1- 5.4±1.3 MPa; Gr2- 4.2±2.4 MPa; Gr3- 4.6±1.5 MPa; Gr4- 3.3±1.7 MPa. The statistical analysis didn't observe influence among the groups (p=0.0966> 0.05). The null hypotheses were accepted. **Conclusion:** The AFP and the IDH do not improve nor diminish the bond strength of fiber post luted to bovine root dentin.

Azeem, R **A comparative evaluation of the fracture resistance under static loading of two different fiber reinforced posts – an in-vitro study.** *2017 IADR No Abstract Number*

Objectives: To compare the fracture resistance under static loading of two different fiber reinforced posts in oval shaped canals using a universal testing machine. **Methods**: Twenty freshly extracted single rooted teeth with oval shaped canals were selected for the study. Teeth were randomly divided into two groups of ten teeth each for each of the two post systems under review namely, group I-**EverStick post**; group II-RelyX fiber post. The clinical crowns were removed; root canal treatment was done on each root and the fiber posts were luted using self-adhesive resin cement according to manufacturer's instructions. The teeth were stored in physiological saline solution at room temperature for 7 days before testing. Each tooth was mounted in autopolymerizing acrylic resin blocks. The specimens were mounted in a jig and fracture resistance under static loading was tested in a Universal Testing Machine. The testing machine was adjusted for a crosshead speed of 2.5 mm/min. Compressive load of 2 mm was applied cervical to incisal edge on palatal aspect till fracture of root, post or core occurred. Data were tabulated and statistically analyzed using independent samples t-test. **Results**: Everstick posts recorded the highest fracture resistance values. The mean fracture resistance under static loading for group I was significantly higher than that of group II. **Conclusions**: Within the limitations of this in vitro study, it can be concluded that using individually formed glass fiber post with direct cementation technique, provides higher fracture resistance than prefabricated fiber posts in oval shaped canals.

Balasubramanian, S., Schulze, K., Roetzer, P., Pipalia, M., Bhattacharyya, M. **Push-out-bond-strength of fiber posts and failure analysis**. *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #2614, 2017(www.dentalresearch.org)*

Objectives: To investigate push-out-bond-strength of fiber posts cemented in root canals in conjunction with either dental cement or dental cement- Fibercones or dental cement-unidirectional fibers. The goal was to find out if additional material in the root canal replacing the cement affects push-out bond-strength. **Methods**: 18 extracted human central incisors were used by cutting off crowns. Root canals have been performed using rotary instruments (WaveOneGold,Dentsply) up to size Large(040.08and25mm). The canals have been filled with gutta percha points and sealed (Ribbond,ThermaSealPlus,Dentsply). Unicore post drills(size-yellow) were used for 12mm into the canal. The canal was flared out from a bottom diameter of 1.15mm to a top diameter of 3.2mm using a prefabricated master pattern. The 18 roots were divided into 3 groups: 1.one fiber post cemented (Unicore, Ultradent,size-yellow) with the Prelude adhesive system(Danville) using Rockcore cement A2 in the auto-cure mode (BASELINE). 2.same size fiber post in the center and 3 additional Fibercones (**RTD, France)** inserted around(CONES). 3.same post size and additional unidirectional fibers (**Quartz Splint UD, RTD, France**) for 5mm into the canal (FIBERS). The roots have been stored for 24h at 100% humidity and 37°C before sectioning into 1 mm slices to obtain a coronal, middle and apical slice. All slices have been subjected to a push-out-bond-strength-test at a universal-testing-machine INSTRON-1011 at a crosshead speed of 1mm/min. Regression analysis using R-Software was used at a 95% confidence interval. **Results**: A statistical significant difference was found among the groups(p=0.0173) and among the position(p=0.0024). The FIBERS group replaced the most cement and reduced shrinkage from dentinal walls and from the post surface. While BASELINE and CONES group showed more adhesive failures between dentin/cement, the FIBERS group showed adhesive failure between post/cement. **Conclusions**: This study concludes that more replacement of the cement in the root canal with solid filling materials can help increase the bond strength and reduces stress at the dentin-cement interface.

Baldissara, P.,, V., Valandro, L.F. Arena, A., Scotti, R. **Non-axial Loading of crowns supported by new fiber post systems. *J Dent Res. Vol 89 (Spec. Iss. B) Abstract #2195, 2010 (www.dentalresearch.org)*

Objectives: to evaluate the behavior of non-circular fiber post and accessory posts in supporting non-axially loaded cast metal crowns. Concerns remains about fiber posts used under crowns connected to RPDs using frictional attachments: the hypothesis tested is that an increase in the emerging section of fiber posts doesn't affect the restoration survival rate**. Methods:** 4 groups: 1)non-circular fiber post concept Ellipson; 2) Fibercone secondary post system (two posts) coupled with one DT Light-Post Illusion #0.5; 3) conventional DT Light-Post Illusion #1; and 4) Macro-Lock Illusion #1, all from RTD, France. 48 single rooted, crownless human teeth were selected and endodontically treated. The canal shape was standardized using the Ellipson ultrasonic diamond tip (Suprasson P5 Newtron, Satelec, France) to obtain a non-circular section, then the teeth were randomly distributed to the 4 groups. Panavia F and Photocore (Kuraray) were used as luting and core materials, respectively. Core was made using transparent shells. The specimens were prepared with chamfer margins and 1.5mm ferrule height. Cast metal crowns with 5mm off-set extensions were made using CrCo alloy (Vivi) and luted with Fuji Plus (GC). The crowns were subjected to 3.2 million cycles ranging from 100N to 150N under water irrigation. Kaplan-Meyer survival analysis was performed to compare the groups (α=.05). **Results:** the Fibercone accessory post group showed the highest survival rate (0.667), followed by Ellipson (0.583) and Macro-Lock (0.500) groups. Conventional DT post showed the lowest survival rate (0.333). The difference among the groups was not statistically significant (p=0.068). **Conclusion:** Since non-axial loading generates torsion forces, non-circular post design could better resist this type of stress. Although the number of the specimens is too low to reject the null hypothesis, the survival data suggest that complete crowns restored with accessory and non-circular fiber posts have a higher survival rate in comparison to conventional posts.

Belli, S., Eraslan, O., Eraslan, O., Eskitascioglu, G. Effect of post-restoration on stress-distribution in roots with over-flared canals. J Dent Res. Vol 91 (Spec. Iss. B) Abstract #160067, 2012 (www.dentalresearch.org)

Objective: The aim of this finite element analysis (FEA) study was to test the effect of five different restorative techniques on stress distribution in roots with over-flared canals. **Method:** Six types of three-dimensional (3-D) FEA mathematical models simulating a maxillary incisor with supporting structures were created as follows: a) sound; b) with an over-flared root-canal restored using a prefabricated post; c) restored using one main and two accessory posts; d) restored with i-TFC system (Sun Medical, Japan); e) the thickness of the a root has been increased using composite resin and the root was then restored using a prefabricated post; f) an over-flared root restored with an anatomic post. The cores were created using composite resin. A 300-N static vertical occlusal load was applied on the node at the center of occlusal surface of the tooth to calculate stress distributions. Solidworks / Cosmosworks structural analysis programs were used for FEA analysis. **Result:** The analysis of the von Mises stress values revealed that accessory post and i-TFC post system showed almost similar stress distribution. They both showed high stress areas at the buccal side of the root (3.67 MPa) and at the cervical region (>3.67 MPa) and low stress accumulation within the post space (0-1 MPa). Anatomic post has kept the stress inside its body and forwarded less stress towards the remaining tooth and root structure and has showed an advantage for the remaining root structure. **Conclusion:** Creation of an anatomic post using composite resin and glass fiber post can save the remaining tooth structure in roots with over-flared canals.

**Boksman, L, Hepburn, AB, Kogan, E, Friedman, M, de Rijk, W. Fiber post techniques for anatomical root variations. Dent Today. 2011 May;30(5):104, 106-11.

In contemporary dental practice, there is no remaining reason to use metallic posts, custom or prefabricated. Many cases that several years ago would have required a retentive post will not require that post today, because of the many improvements in bonding agents and composite resin restoratives. However, in cases where less than 50% of coronal tooth structure remains--or in other cases wherein the judgment of the clinician a post is indicated--there are now aesthetic, non-corrosive, fracture resistant and radiopaque alternatives for all varieties that save time and money without compromise. Their most compelling advantage, regardless of the geometry or amount of residual tooth structure, is the protection from root fracture that a low modulus restoration provides. In selecting the materials (posts, resins) for these techniques, the dentist is advised not to cut corners, and to seek the strongest and most radiopaque products available. **PDF**

Bonfante, G, Kaizer, O.B, Pegoraro, L.F, do Valle, A.L. **Fracture strength of teeth with flared root canals restored with glass fibre posts.** *Int Dent J. 2007 Jun;57(3):153-60.*

Objective: to investigate the fracture strength and pattern of failure of teeth with weakened roots reconstructed by different procedures. **Methods:** In an in vitro study root posts were placed in 50 endodontically treated canines, divided into 5 groups (n=10) as follows: cast metallic post; glass fibre post with smaller diameter than the root canal; glass fibre post with smaller diameter than the root canal + glass fibre strips; glass fibre post with smaller diameter than the root canal + accessory glass fibre posts; anatomical post (glass fibre post with smaller diameter than the root canal, relined with low viscosity composite resin). Posts were luted with resin cement and the coronal portion of posts was constructed with composite resin. Metallic crowns were cemented on the posts. Specimens were submitted to compressive load in a universal testing machine. Fracture strength values of each group were compared. **Results:** Fracture strength values were for Groups 1-5 respectively: 1087.06; 745.69; 775.41; 920.64; 876.12 kgf, with significant differences between Groups 1 and 2 and between Groups 1 and 3 ($p<0.05$). Observed patterns of fracture were: Group 1 – 100% of roots fractured; Groups 2 and 4 – variable fracture patterns; Group 3 – 60% of fractures occurred in the cervical root

third; Group 5 - 50% of failures occurred in the coronal portion of the post. **Conclusions:** The fracture strength of teeth with cast metallic posts, teeth with anatomical posts or teeth with glass fibre posts combined with accessory posts was similar. All teeth restored with cast metallic posts presented fractures and were unfavourable to maintenance of the remaining tooth structure. Teeth with fibre posts (Groups 2 to 5) presented variable fracture modes; however, the maximum percentage of unfavourable fractures was 30%. **PDF**

Braz, R, Conceição, AAB, Conceição, E.N., Loretto, S.C., Lyra, A.M.V.C., Silva, .A.K.S. **Evaluation of reinforcement materials used on filling of weakened roots**. *J Dent Res. Vol 84 (Spec. Iss. A) Abstract #1733, (www.dentalresearch.org)*

Objectives: The purpose was to evaluate flexural strength of glass fiber posts associated with filling materials used for root reinforcement, and fracture resistance of flared roots reinforced with the same materials. **Methods:** For flexural test, 10 cylinders, 3.5mm (diameter) and 14mm (length), were made for each group, according to the reinforcement material used: G1 - Reforpost (Angelus)+dual resin cement Variolink II (Ivoclar/VIvadent); G2 - Reforpost+dual composite core BisCore (Bisco); G3 - Reforpost+three accessory posts Reforpin(Angelus)+Variolink II. Cylinders were dry stored (24h) and tested in a universal testing machine (0.5mm/min). For fracture resistance test, 30 human maxillary canines were used and their crowns removed at the cement-enamel junction (CEJ). The canals were endodontically treated, after which the fillings were removed and the canals widened by 3.5mm, simulating flared canals. The dual adhesive system Excite DSC (Ivoclar/Vivadent) was applied to the roots, which were randomly divided into 3 groups as performed for flexural strength test. After the cementation, coronal complements were made with composite-resin and the roots were assembled in metallic cylinders filled with self-curing acrylic-resin 2mm below the CEJ. After storage (24h), the samples were fixed at a 45º angle to a metal funneled tip that applied a force on the lingual surface (0.5mm/min). Statistics were performed using analysis of variance and Tukey`s test (5%). **Results:** The flexural mean values (MPa) were: G1 - 206.52, G2 - 224.39 and G3 – 272.64, showing a statistically difference between the reinforcement materials used, with G3 presenting statistically higher flexural strength compared to other groups. For fracture resistance, mean values (Kgf) were: G1 – 47.45, G2 – 66.57 and G3 – 74.11, showing that G1 presented a statistically lower mean value than the other groups. **Conclusion:** Therefore, it was possible to conclude that glass fiber post, associated with accessory posts, is the method of choice for reinforcing structurally weakened roots.

Caceres, EA , Sampaio, CS , Atria, PJ , Moura, H, Giannini, M , Coelho, PG , Hirata, R . **Void and gap evaluation using micro-computed tomography of different fiber post cementation techniques.** *J Prosthet Dent. 2017 Apr 28. pii: S0022-3913(17)30080-X. doi: 10.1016/j.prosdent.2017.01.015*

Statement of problem: Few studies have investigated the voids and gaps produced during the cementation of fiber posts using different techniques. **Purpose:** The purpose of this study was to evaluate and quantify void and gap area formations of different fiber post cementation techniques using microcomputed tomography (μCT). **Material and methods:** Standardized endodontically treated acrylic resin roots (N=24) were divided into 4 groups (n=6) according to different fiber posts cemented with the resin cement (FB); fiber posts relined with composite resin followed by cementation (FBR); fiber posts cemented using an ultrasonic device (FBU); and fiber posts relined with composite resin and cemented using an ultrasonic device (FBRU). Each specimen was scanned twice using micro-computed tomography (μCT; empty root, followed by after fiber post cementation). Digital imaging and communications in medicine (DICOM) files were transferred into 3-dimensional (3D) reconstruction software for analysis. Void volume in the cementation system and gap area formation were evaluated; quantitative and qualitative analyses were performed. The data were analyzed using 2-way ANOVA and the Tukey honest significant difference post hoc test (α=.05). **Results:** FBR showed a lower percentage of voids than obtained for FB (P<.05). Groups FB, FBU, and FBRU did not show significant difference in void formation (P>.05). No significant differences were found in gap area formations among the experimental groups (P>.05). **Conclusions:** The use of a composite resin to reline the fiber post significantly decreased the void formation in the cementation procedure when no ultrasonic device was used. The use of an ultrasonic device did not decrease the percentage of void or gap formation for any technique evaluated.

Cardoso, P.E., Valera, M.C., Oliveira, L.D., Camargo, C.H.R Carvalho, C.A.T**. Fracture resistance of endodontically treated immature roots after different reinforcements.** *J Dent Res. Vol 90 (Spec. Iss. A) Abstract # 3103, 2011 (www.dentalresearch.org)*

Objectives: This study evaluated fracture resistance of brittleness bovine teeth simulating immature teeth, that received different reinforcements within radicular canal. This evaluation was made in comparison to teeth without reinforcements within radicular canal and teeth no brittleness. **Methods:** For that purpose, seventy bovine mandibular incisors were selected; of these, 56 were internally prepared, and then to simulating immature roots, were enlarged with Gates-Glidden, fast steel and videa burs. The specimens were distributed into five groups (n= 14): a) carbon fiber post and three accessory glass fiber posts; b) carbon/glass post and three accessory glass fiber posts; c) composite resin reinforcement; d) without reinforcement and e) without canal preparation and without reinforcement . The specimens were submitted to the fracture resistance testing with application of tangential compressive loading at an angle of 45º, at a speed equivalent to 1mm/min until the fracture using EMIC machine. **Results:** Results were subjected to statistical analysis (Tukey, t student and Dunnet), at a significance level of 5%. Results indicated statistically significant

differences (p <0,05) in relation to root conditions. G1 presented higher resistance in comparison with other groups and G4 presented smaller resistance. **Conclusion:** It could be ended like this that the use of intra-radiculars reinforcements with different posts or resins composite increased fracture resistance of brittleness teeth under compression force.

Clavijo, V.G, Reis, JM, Kabbach, W, Silva, AL, Oliveira Junior, OB, Andrade, MF. **Fracture strength of flared bovine roots restored with different intraradicular posts**. *J Appl Oral Sci. 2009 Nov-Dec;17(6):574-8.*

Objective: The aim of this study was to evaluate the fracture strength and failure mode of flared bovine roots restored with different intraradicular posts. **Methods:** Fifty bovine incisors with similar dimensions were selected and their roots were flared until 1.0 mm of dentin wall remained. Next, the roots were allocated into five groups (n=10): GI- cast metal post-and-core; GII- fiber posts plus accessory fiber posts; GIII- direct anatomic post; GIV- indirect anatomic post and GV- control (specimens without intraradicular post). A polyether impression material was used to simulate the periodontal ligament. After periodontal ligament simulation, the specimens were subjected to a compressive load at a crosshead speed of 0.5 mm/min in a servo-hydraulic testing machine (MTS 810) applied at 135 masculine to the long axis of the tooth until failure. The data (N) were subjected to ANOVA and Tukey's post-hoc test (alpha=0.05). **Results:** GI and GIV presented higher fracture strength (p<0.05) than GII. GIII presented intermediate values without statistically significant differences (p>0.05) from GI, GII and GIV. Control specimens (GV) produced the lowest fracture strength mean values (p<0.05). Despite obtaining the highest mean value, GI presented 100% of unfavorable failures. GII presented 20% of unfavorable failures. GIII, GIV and GV presented only favorable failures. **Conclusions:** Although further in vitro and in vivo studies are necessary, the results of this study showed that the use of direct and indirect anatomic posts in flared roots could be an alternative to cast metal post-and-core. **PDF**

Costa, R.G.,Morais, E.C.C. Moreira-Da-Silva, S.M.L. Michel, M.D., Gonzaga, C.C.,Correr G.M. Bindo, M.J.F., Campos,E.A., **Fatigue and fracture resistance of customized fiber dowel**. *J Dent Res. Vol 90 (Spec. Iss.A) Abstract # 3103, 2011 (www.dentalresearch.org)*

Objectives: The aim of this study was to evaluate the root fracture strength of human unirradicular premolars restored with customized fiberglass dowel-core systems after fatigue simulation. **Methods:** Forty premolars with standard dimensions were chosen, cleaned, and stored in 0.5% chloramine T. The crowns were cut and the root length was standardized to 13 mm. The teeth were endodontically treated and embedded in acrylic resin. The specimens were distributed into 4 groups (n = 10) according to the restorative material used: G1 (prefabricated fiber post), G2 (prefabricated fiber post + accessory fiber posts), G3 (prefabricated fiber post + unidirectional fiberglass), and G4 (unidirectional fiberglass customized post). All posts were luted using resin cement and the cores were build-up with a composite resin, following manufacturer instructions. The samples were stored for 24 hours at 37°C and 100% relative humidity and then submitted to mechanical cycling (250.000 cycles with 30 N at a frequency of 2 Hz). The specimens were then compressive-loaded in a universal testing machine with a 3000 N load cell at a crosshead speed of 0,5 mm/min until fracture. The failure patterns were analyzed and classified. Data was submitted to statistical analysis (one-way ANOVA and Tukey's test) at a significance level of 5%. Descriptive analysis was used to assess the failure pattern. **Results:** The mean values of maximum load (N) were: G1 - 811,4 ± 124,3; G2 - 729,2 ± 157,2; G3 - 747,5 ± 204,7; G4 - 762,4 ± 110. Statistical differences were not observed among the groups. G1 showed more catastrophic failures than the other groups. G2, G3, and G4 showed 100% non-catastrophic failures. **Conclusions:** It can be concluded that dowel-core techniques do not interfere with the fracture strength of the tooth/dowel/core system; conversely, customized posts showed reversible and favorable type of failures.

Costa, RG, De Morais, EC, Campos, EA, Michel, MD, Gonzaga, CC, Correr, GM. **Customized fiber glass posts. Fatigue and fracture resistance.** *Am J Dent. 2012 Feb;25(1):35-8*

Purpose: To evaluate the root fracture strength of human single-rooted premolars restored with customized fiberglass post-core systems after fatigue simulation. **Methods:** 40 human premolars had their crowns cut and the root length was standardized to 13 mm. The teeth were endodontically treated and embedded in acrylic resin. The specimens were distributed into four groups (n=10) according to the restorative material used: prefabricated fiber post (PFP), PFP+accessory fiber posts (PFPa), PFP+unidirectional fiberglass (PFPf), and unidirectional fiberglass customized post (CP). All posts were luted using resin cement and the cores were built up with a resin composite. The samples were stored for 24 hours at 37 degrees C and 100% relative humidity and then submitted to mechanical cycling. The specimens were then compressive-loaded in a universal testing machine at a crosshead speed of 0.5 mm/minute until fracture. The failure patterns were analyzed and classified. Data was submitted to one-way ANOVA and Tukey's test (alpha = 0.05). **Results:** The mean values of maximum load (N) were: PFP - 811.4 +/- 124.3; PFPa - 729.2 +/- 157.2; PFPf- 747.5 +/- 204.7; CP - 762.4 +/- 110. Statistical differences were not observed among the groups. All groups showed favorable restorable failures. Fiberglass customized post did not show improved fracture resistance or differences in failure patterns when compared to prefabricated glass fiber posts.

Costa, RG, de Morais, EC, Leão, MP, Bindo, MJ, Campos, EA, Correr, GM. **Three-year follow up of customized glass fiber esthetic posts.** *Eur J Dent. 2011 Jan;5(1):107-12.*

Customized glass fiber posts that is well adjusted into the root canal and have mechanical properties similar to those of dentin may be a suitable treatment for severely compromised endodontically treated teeth. This article reports a 3-year follow up of severely

damaged endodontically treated teeth restored with unidirectional fiber glass customized post and core system instead of a conventional fiber post. The fabrication of this glass fiber customized post is a simple technique, providing an increased volume of fibers into the root canal, and an adequate polymerization of the post-core system. Over a three-year period, the treatments demonstrated good clinical and radiographic characteristics, with no fracture or loss of the post and/or crown. This technique can be considered effective, less invasive, and suitable for restore endodontically treated teeth.

da Rosa RA, Barreto MS, da Rosa TA, Reis KR, Kaizer OB. Fracture resistance of weakened teeth restored using accessory glass fiber posts. Gen Dent. 2013 Mar-Apr;61(2):45-9.

This study used differential root weakening to evaluate the fracture resistance of bovine teeth restored using glass fiber posts (with or without accessory glass fiber posts). Fifty bovine mandibular incisors were sectioned 14 mm from the apex, fixed in acrylic resin blocks, and divided into 5 groups: healthy roots with a glass fiber post (Group 1), partially weakened teeth with a glass fiber post (Group 2), partially weakened teeth with a glass fiber post and 2 accessory glass fiber posts (Group 3), extensively weakened teeth with a glass fiber post (Group 4), and extensively weakened teeth with a glass fiber post and 5 accessory glass fiber posts (Group 5). Posts were luted with resin cement, cores were prepared using composite resin, and metallic crowns were cemented. The specimens were stored in distilled water at 37°C for more than 72 hours until the fracture resistance test. Specimens were loaded at 135 degrees relative to the long axis of the tooth at a crosshead speed of 0.5 mm/minute in a universal testing machine. All groups predominantly exhibited favorable failure patterns and there were no statistically significant differences between groups (two-way ANOVA, $\alpha = 0.05$)

da Silva GR, Santos-Filho, PC, Simamoto-Júnior, PC, Martins, L,R, Mota, A,S,, Soares, C.J. **Effect of post type and restorative techniques on the strain and fracture resistance of flared incisor roots**. *Braz Dent J. 2011;22(3):230-7.*

Restoring flared endodontically treated teeth continues to be a challenge for clinicians. This study evaluated the effect of post types and restorative techniques on the strain, fracture resistance, and fracture mode of incisors with weakened roots. One hundred five endodontically treated bovine incisors roots (15 mm) were divided into 7 groups (n=15). The two control groups were (C) intact roots restored with Cpc (cast posts and core) or Gfp (glass fiber posts). The five experimental groups were (F) flared roots restored with GfpAp (Gfp associated with accessory glass fiber posts), GfpRc (anatomic Gfp, relined with composite resin), and GfpRcAp (anatomized Gfp with resin and accessory glass fiber posts). All teeth were restored with metal crowns. Mechanical fatigue was performed with 3x10(5)/50 N. Specimens were loaded at 45º, and the strain values (μS) were obtained on root buccal and proximal surfaces. Following that, the fracture resistance (N) was measured. One-way ANOVA and Tukey's HSD tests (α=0.05) were applied, and failure mode was checked. **Conclusions:** No significant difference in strain values among the groups was found. Cpc presented lower fracture resistance and more catastrophic failures in flared roots. Gfp associated with composite resin or accessory glass fiber posts seems to be an effective method to improve the biomechanical behavior of flared roots. **PDF**

Deliperi, S. **Direct Fiber-reinforced Composite Restoration in an Endodontically-treated Molar: A Three-year Case Report**.*Operative Dentistry, 2008 33-2, 209-214.*

The proper utilization of fiber-reinforced resin composite restorations in endodontically-treated molars may preclude the use of more extensive restorative treatment, possibly delaying the need for expensive indirect restorations.The reconstruction of structurally-compromised non-vital posterior teeth may represent one of the most challenging adhesive-based restorative procedures. Several factors may influence the longevity of direct fiber -reinforced resin composite restorations: endodontic procedures prior to post cementation, dentin and/or post surface treatments, selection of the appropriate post design and architecture, resin composite polymerization and layering techniques. Thus, different specialties, such as endodontics and restorative dentistry, should work as a team to improve the longevity of restorations. This article presents three -year clinical results following reconstruction of a severely damaged endodontically- treated molar using direct fiber reinforced resin composite systems. **PDF**

*Erkut , S., Gulsahi, K., Caglar, A., Imirzalioglu, P., Karbhari, VM, Ozmen, I. **Microleakage in overflared root canals restored with different fiber reinforced dowels.** *Operative Dentistry, 2008, 33-1, 96-105*

Based on the in vitro results of this study, restoration of a tooth with an overflared root canal, using individually shaped polyethylene reinforced dowels, may help to reduce microleakage. This study evaluated microleakage in overflared root canals restored with four different types of adhesively-luted fiber-reinforced dowels: DT Light-Post (LP), Glassix (GL), Ribbond (RB) and Stick-Tech Post (ST). Forty non-carious, single- rooted mandibular human premolars with straight root canals were prepared using a step- back technique and obturated with gutta-percha using lateral condensation. The restored roots were randomly divided into four groups (n=10). The root canals were over-prepared, creating an over-flared dowel space, and each dowel was adhesively luted using a total-etched adhesive (Single Bond) and dual-polymerizing luting agent (RelyX ARC). All specimens were thermal cycled 1000 times between 5°C and 55°C and stored in 2% methylene-blue solution for one week. The teeth were cut horizontally into three consecutive sections: apical (A), middle (M) and coronal (C). Each section was digitally photographed from the occlusal direction under a stereomicroscope. The images were transferred to a PC and stored in TIFF format. For each image, dye penetration was estimated as the ratio of methylene-blue–infiltrated surface divid- ed by total dentin surfaces. The data were com- pared and statistically analyzed using the Kruskal-Wallis test ($p< 05$). The Mann-Whitney U test was used to compute multiple pairwise

comparisons to determine differences between the experimental groups (p=.083). Dentin-luting agent fiber-reinforced dowel (FRD) interfaces were evaluated under a scanning electron micro- scope. Scanning electron microscopy (SEM) showed detachment of the luting resin from the dentin surface in varying degrees in all specimens evaluated. All groups showed considerable leakage at the sections evaluated. Significant differences were demonstrated between LP-RB for the apical and middle sections and between GL- RB, LP-RB and ST-RB for the coronal sections (p<.0083). Among the FRDs evaluated, the individually shaped polyethylene-reinforced dowel (Ribbond) showed the least overall leakage.

*Fathi, M., Mortazavi, V., Katiraie, N**., Fracture resistance of endodontically treated teeth restored with esthetic posts**. *J Dent Res. Vol 87 (Spec. Iss. A) Abstract #1857 (www.dentalresearch.org)*

Objectives: This study compared the effect of three esthetic post systems with different modulus of elasticity on the fracture resistance and fracture patterns of endodontically treated teeth with structurally compromised and normal roots. **Methods:** Forty five extracted and root canal treated central incisors were assigned to 2 main experimental groups called "narrow" and "flared" canals. Narrow-canal group divided into 2 and flared-canal group, divided into 3 experimental subgroups (n=9). For narrow-canal subgroups, post spaces were prepared with the corresponding drills to restore with quartz fiber double taper light posts (D.T. Light-Post; RTD) [subgroup A] and zirconia posts (CosmoPost;Ivoclar) [subgroup B]. For the flared-canal subgroups, thin–walled canals were simulated, and restored with quartz fiber double taper light posts[subgroup C], quartz fiber double taper light posts inserted within the polyethylene woven fibers (Ribbond;Ribbond,Inc) [subgroup D] and zirconia posts[subgroup E]. All posts were cemented with dual–polymerizing adhesive resin cement (Panavia F; Kuraray).After restoration of access cavity with composite and thermocycling, compressive load was applied to the palatal surface of tooth until fracture. Mean failure load values were analyzed using One-way ANOVA and Tukey test (P<0.05).Mode of failure was evaluated with Fisher exact test (P<0.05). **Results:** The mean failure loads ± SD were 678.55±90.86, 603.44±68.66, 638.22±93.71, 732.44±81.78, and 573.66±91.340 N for subgroups A to E, respectively. Subgroup D exhibited significantly higher resistance to fracture compared to subgroups B, C and E (P<0.05). Subgroup E showed significantly less fracture resistance compared to subgroups A and D (P<0.05). Subgroups B and E showed more root fracture compared to subgroups A, C, and D (P=0,004). **Conclusion:** Significantly higher fracture resistance was observed in flared root canal treated teeth restored with quartz fiber double taper light posts + polyethylene woven fibers. Zirconia posts showed lower fracture resistance and significantly more root fracture compared to fiber posts.

Fráter, M, Forster, A, Jantyik, Á, Braunitzer, G, Nagy, K, Grandini, S. **In vitro fracture resistance of premolar teeth restored with fibre-reinforced composite posts using a single or a multi-post technique**. *Aust Endod J. 2016 May 6. doi: 10.1111/aej.12150. [Epub ahead of print]*

The purpose of this study was to evaluate the reinforcing effect of fibre-reinforced composites (FRC) applied in premolar teeth with different techniques and minimally invasive post space preparation. Fifty extracted and endodontically treated premolar teeth were used. The teeth were divided into five groups (n = 10) depending on the restorative technique (Groups 1-5). Group 1: one single conventional post, Group 2: one main conventional and one collateral post, Group 3: one elastic post, Group 4: one main elastic and one collateral post, and Group 5: individual post formed of elastic posts. After cementation and core build-up, the specimens were submitted to static fracture resistance test. Fracture thresholds and fracture patterns were measured and evaluated. Group 4 showed the highest average fracture resistance among the tested groups. The multi-post techniques (group 2 and 4) exhibited statistically higher fracture resistance compared to group 1. Regarding fracture patterns, there was no statistically significant difference between the tested groups. Within the limitations of this study, the application of multiple elastic or conventional FRC posts or a single elastic post in the same root canal is beneficial in terms of fracture resistance compared to a single conventional FRC post. The elasticity or the number of posts did not influence the fracture patterns. **PDF**

*Geramipanah, F, Rezaei ,SM, Sichani, SF, Sichani, BF, Sadighpour, L. **Microleakage of different post systems and a custom adapted fiber post**. *J Dent (Tehran). 2013 Jan;10(1):94-102. Epub 2013 Jan 31.*.

Objective: The effects of closely adapting a prefabricated fiber to the post space remain unknown. The purpose of this study was to quantify the microleakages of a custom adapted fiber-reinforced post, a prefabricated quartz fiber post and a cast post using nondestructive methods. **Methods:** Sixty-five extracted human premolars were endodontically treated and randomly divided into three groups (n=15), which were restored using a cast post-and-core, a custom adapted fiber post (Refropost) with a micro-hybrid microfiller resin composite (Gradia), or a prefabricated quartz fiber post (DT Light-Post) and two groups of control (n=10). All groups were cemented using a dual polymerizing resin cement (Panavia F2.0). A composite core (Z100) was used for the fiber posts. The microleakage was calculated for the experimental and control groups before and after thermal cycling and cycling loading using a radiotracer solution (thallium 201 chloride) and a gamma counter device. Data were subjected to statistical analysis of ANOVA and Tukey HSD at significant level of P< 0.05. **Results:** Significantly lower microleakage values were found for the cast post-and-core (mean value =16.04 ×10(4)) and custom adapted fiber post groups (mean value=14.36×10(4)). Thermal cycling and cyclic loading had no significant effect on the microleakage value of any tested group. **Conclusion**: Post systems with improved adaptation showed similar microleakage to casting posts. **PDF**

Gomes, GM, Rickli, EH., Gomes, OMM, Rezende, EC, Gomes, JC, Loguercio, AD, Reis, A. **Fracture strength of bonded fiber-post techniques to flared roots.** *J Dent Res.Vol 92 (Spec Iss A) Abstract #1852, 2013 (www.dentalresearch.org)*

Objectives: The aim of this study was to evaluate the effect of alternative techniques to improve the adaptation of pre-fabricated fiber posts (FP) to oversized dowel spaces on the tooth fracture resistance (FR) of metal-free restorations after mechanical fatigue (MF). **Methods:** The root canals of 24 single-rooted mandibular premolars were prepared, and they were randomly divided into 4 groups. In groups GPC (positive control), the root canal was prepared with a drill compatible with the FP # 0.5 (Whitepost DC, FGM). In groups GNC (negative control), GAP (accessories posts) and GAD (anatomical direct post), oversized root canals were prepared and the FP # 0.5 were cemented without any additional technique (GNC), with accessories post (GAP) and after individualization of the FB with a composite resin (GAD). The luting procedures were performed with the adhesive Excite DSC and the resin cement Variolink II (Ivoclar Vivadent) according to the manufacturer's recommendations. Metal-free crowns were cemented on composite resin cores, the periodontal ligament was simulated and the specimens were submitted to MF (1.2×10^6 cycles, 30 N) followed by FR test at a compressive load (0.5 mm/min). The data were subjected to one-way ANOVA and Tukey's tests ($\alpha = 0.05$). **Results:** The means and standard deviations of FR (N) for each group were: GPC: 1024.1±26.5, GNC: 740.8±126.2, GAP: 1051.9±200.6 and GAD: 785.5±17.0. The highest FR values were observed for GPC and GAP ($p < 0.0001$), which were similar one another. **Conclusion:** To improve the fracture resistance of metal-free crowns bonded to oversized root canals, it is advisable to use prefabricated fiber posts in combination with accessories posts.

Goncalves, L., Rocha,A., Carvalho, C,Tavarez, R., **Effect of relining fiber post on retention to root canals**. *J Dent Res. Vol 95 (Spec. Iss. A) Abstract #1072, 2016 (www.dentalresearch.org)*

Objectives: This study investigated the effect of relining fiber post on retention to root canals by evaluating the cementation layer and adhesive resistance. **Methods**: Twelve human maxillary central incisors had their root canals treated endodontically and were randomly distributed into two groups (n=6): control group, where glass fiber posts were cemented using the self-etch system Rely-X U200 following manufacturer's directions; and relined group, where glass fiber posts were relined using direct resin composite followed by cementation using the same system. After seven days of cementation, the roots were sectioned in three sections (cervical, middle and apical) and each section was photographed using a stereomicroscopy. All images were analysed by ImageJ software and the cementation layer was investigated for the area occupied by bubbles. Also, each root section was evaluated for the adhesive resistance by push-out test (EMIC; 0.5 mm/min speed). Data was analysed by ANOVA and Student T-test with a significance level of 5%. **Results**: Significant differences were observed between groups, in all root sections, for the area occupied by bubbles ($p < 0.05$). The area occupied by bubbles in the relined group was much lower than in the control group ($p < 0.001$), showing a cementation layer more homogeneous. Also, the adhesive resistance in the relined group, in all root sections, was higher compared to the control group ($p < 0.05$). **Conclusions**: It was concluded that the relining process of glass fiber posts with direct resin composite improved its retention to root canals.

*Grandini, S, Goracci, C, Monticelli, F, Borracchini, A, Ferrar,i M. **SEM evaluation of the cement layer thickness after luting two different posts.** *J Adhes Dent. 2005 Autumn;7(3):235-40.*

Purpose: To verify with SEM the cement layer thickness and uniformity of resin-relined translucent fiber posts (anatomic posts) and standard translucent fiber posts. **Methods:** On 20 extracted maxillary anterior teeth, the roots were endodontically treated and prepared for the insertion of a fiber post. Translucent fiber posts (DT) were luted with a dual-curing resin cement (Duo-Link) in 10 specimens (group 1) after the canal walls had been treated with the One-Step bonding system. In the other 10 specimens (group 2), experimental anatomic posts (Anatomic Post'n Core, RTD St Egreve, France) were tested. To these posts, a layer of light-curing resin is added to allow for a pre-cementation relining of the post, aimed at improving its fit into the endodontic space. For luting, the same adhesive-resin cement combination of group 1 was used. All the roots were sectioned and prepared for SEM observations. At the 1-mm, 4.5-mm, and 8-mm level of each root, cement thickness was measured, and the presence of gaps or voids within the luting material or at its interfaces was evaluated. A statistical analysis was performed to test the significance of differences in the cement layer thickness around the two types of post and at different levels of the same type of post. **Results:** In the presence of anatomic posts, the cement layer was significantly thinner and more uniform at the coronal and middle level of the root. In both groups, voids and bubbles were detected within the luting material, within the abutment material, and between fiber post and cement. Gaps were also visible between post and relining material. **Conclusions:** The resin cement thickness was significantly lower in the anatomic post group than in the control group (standardized posts), except at the apical third of the canal, where there was no statistically significant difference. A good adaptation of anatomic posts was evident in all of the specimens.
PDF

Jimenez, M. P., Yaman, P., Dennison, J.D., et al **Fracture resistance of endodontically treated teeth restored with composite posts.** *J Dent Res. Vol 81 (Spec. Iss. A) Abstract #0323, 2002 (www.dentalresearch.org).*

The most recent application of fiber-reinforced composites involves their use as post and core systems to restore endodontically treated teeth. Even though this last application has been advertised and been used clinically by many dentists, there is very little information regarding the physical properties of these posts. **Objectives:** The purpose of this study was to compare the fracture resistance and mode of failure of endodontically treated teeth restored with fiber-reinforced composite posts. **Methods:** Ninety maxillary central incisors were divided into eight experimental groups and one control group of 10 samples each. Teeth from the two experimental groups called "Narrow" and "Flared" canals were restored with Fibre-Kor, Lucent Anchors and Ribbond posts

using two different cementation techniques. Specimens were loaded to failure using an Instron machine. **Results:** Statistical analysis using two-way ANOVA revealed no significant difference between flared and narrow canals in mean load to failure between the post systems except for the Ribbond posts. For the narrow canal, the mean load ranged from a low of 4.55 (±1.49) Kg for the Ribbond Standard to a high of 12.9 (±1.64) Kg for the Lucent Anchors while for the flared canal the low mean was 9.04 (±1.76) for Fibre-Kor and the high of 12.87 Kg was equal for both Lucent Anchors and Ribbond Standard. Overall, the ParaPost control group had the highest load value (18.33 ±3.27 Kg). No root fractures occurred in any of the experimental groups**. Conclusions**: Results from the study suggest that the mode of failure or deflection of the fiber reinforced composite posts is protective to the remaining tooth structure. Considering the high risk of fracture and the possibility of re-treatment of endodontically treated teeth, the use of these new post systems seems to represent a conservative option when restoring debilitated root canals.

Jindal, S., Jindal, R, Mahajan, S, Dua, R, Jain, N, Sharma, S. **In vitro evaluation of the effect of post system and length on the fracture resistance of endodontically treated human anterior teeth**. *Clin Oral Investig. 2012 Jan 14. [Epub ahead of print]*

Objectives: The aim of this study was to evaluate the effect of post system and length on the fracture resistance of endodontically treated human anterior teeth. **Methods:** Seventy-five extracted human incisors were endodontically treated, out of which 60 were decoronated 2 mm above the cementoenamel junction and divided into two experimental groups based on the type of post system to be used: glass fiber post (GFP) and Ribbond fiber post groups (RFP). Endodontically treated human anterior teeth in which no post was placed served as control group. Each group was divided into two subgroups according to the length of post space: 5 and 10 mm and all the samples were restored with metal crowns. The fracture resistance was measured by applying loads at an angle of 130° to the long axis of teeth in an Instron universal testing machine. **Results:** The results revealed that GFP group at 10-mm post space length showed the significantly highest fracture resistance (740.2133 N) among all groups and subgroups. Decrease in post length resulted in the decrease in fracture resistance in GFP group (425.1867 N), whereas in group RFP 5-mm subgroup (299.6200 N) showed significantly higher fracture resistance than 10-mm subgroup (216.9300 N) but lesser than the control (437.8733 N) in both the subgroups. **Conclusions:** Glass fiber posts efficiently increase the fracture resistance of an endodontically treated tooth but the determination of optimal postlength is also essential. The present investigation highlights the significance of using glass fiber posts in the restoration of endodontically treated teeth. Endodontically treated teeth restored with glass fiber posts showed increased fracture strength and favorable mode of fracture, and are therefore highly recommended to achieve better clinical outcomes. **PDF**

Kececi , A.D., Ureyen Kaya, B, Adanir, N. **Micro push-out bond strengths of four fiber-reinforced composite post system and 2 luting materials**. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008 Jan;105(1):121-8*

Objectives: The aim of this study was to compare the bond strengths of 2 types of dual-cured luting agents used for cementation of 4 different fiber-reinforced composite (FRC) posts by using a push-out test and to evaluate the failure modes of these systems. **Methods:** Eighty human maxillary central incisors were divided into 8 groups (n = 10), decoronated, and roots filled and restored with one of the following post systems: groups 1 to 4: translucent quartz FRC posts; groups 5 and 6: opaque glass FRC post; and groups 7 and 8: individually formed electrical glass fiber post. Cementation was performed with 2 types of dual-polymerizing resin luting agents: Variolink II (groups 1, 3, 5, and 7) and a new self-adhesive resin cement, RelyX Unicem (groups 2, 4, 6, and 8). Slices with a thickness of 1.00 +/- 0.05 mm were prepared from the coronal third of each root by using a low-speed saw. Push-out tests were performed at a crosshead speed of 1 mm/min by using a universal testing machine, and the data was statistically analyzed (analysis of variance [ANOVA] and Duncan tests; $P < .05$). Fracture modes were evaluated at original magnification x40. **Results:** Micro push-out bond strengths were significantly affected by the type of luting agent and the type of post ($P < .05$, 2-way ANOVA). A significant difference was found among the groups (1-way ANOVA, $P < .05$). Fiber-reinforced composite posts luted with Variolink II showed higher bond strengths, and the groups ordered as 5, 1, 3, 7, 6, 2, 4, and 8, with the values (MPa, mean +/- SD): 13.80 +/- 5.00, 13.77 +/- 3.78, 12.20 +/- 4.79, 9.39 +/- 2.48, 9.21 +/- 7.76, 7.25 +/- 1.56, 3.89 +/- 4.41, and 3.77 +/- 1.20, respectively. Adhesive failures between dentin and cement were observed more than cohesive failures in cement or post. **Conclusions:** Push-out bond strengths can be affected by luting agent and post type. Variolink II and fiber post combinations resulted in high bond strength values.**PDF**

Kimmel SS. **Restoration and reinforcement of endodontically treated teeth with a polyethylene ribbon and prefabricated fiberglass post.** *Gen Dent. 2000 Nov-Dec;48(6):700-6.*

In the past it was considered appropriate to place a cast post and core in every pulpless tooth without regard to the remaining supportive tooth structure present. Recent research and the advent of adhesive bonding techniques have caused clinicians to reevaluate their restorative protocol. This article reviews the current literature with regard to restoration of the endodontically treated tooth and presents a method for restoration and reinforcement utilizing a combination of polyethylene ribbon and a prefabricated fiberglass post.

Kivanc¸ BH, et al. **Fracture resistance of thin-walled roots restored with different post systems.** *International Endodontic Journal, 42, 997–1003, 2009. doi:10.1111/j.1365-2591.2009.01609.x*

Aim: To compare the fracture resistance of thin-walled roots after restoration with different types of post systems. Methodology One hundred and sixty-five decoro- nated maxillary central incisors were root filled and randomly assigned to three groups with respect to the remaining dentine thickness of root (1.0 mm, 1.5 mm, 2.0 mm). Each group was randomly divided into five equal subgroups. The subgroups were restored with one of the following post systems: polyethylene woven fibre (R), composite resin cured by light-transmitting post + glass fibre post (L), electrical glass fibre post (E), composite corono-radicular restoration (C) and cast metal post (M). Standard cores were constructed using composite resin in the first four groups. The samples were subjected to a gradually increasing force (1 mm min)1). The force required to fracture was recorded. The data was analysed with anova and Tukey test (P = 0.05). **Results:** The cast metal post group had the highest fracture strength (P < 0.001). There was no significant difference in fracture resistance between the other four groups. Fracture resistance was affected largely by the remaining dentine thickness in fibre post groups; how- ever, the difference was not significant. On the contrary in the cast metal post group load failure was inversely influenced by axio-proximal dimension of dentine walls. **Conclusion:** The cast post group had a higher fracture strength than resin groups. The force required to fracture the roots was similar for all fibre post systems and for all dentine thicknesses.

Li Q, Xu B, Wang Y, Cai Y. **Effects of auxiliary fiber posts on endodontically treated teeth with flared canals. *Oper Dent. 2011 Jul-Aug;36(4):380-9. Epub 2011 Aug 11.*

This study investigated the fracture resistance and retention of endodontically treated roots with over-flared canals restored with different post systems, including one cast metal post and four fiber posts with/without auxiliary fiber posts. One hundred endodontically treated incisor roots were experimentally flared using a tapered diamond bur. The roots were restored using one of the five post systems: Ni-Cr cast metal post (CM), D.T. Light glass fiber post (DT), Macro-Lock glass fiber post (ML), ML+2 Fibercone auxiliary fiber posts (2FC), and ML+5 Fibercone auxiliary fiber posts (5FC). After fabrication of the crowns, half of the specimens (n=50) were subjected to a fracture failure test-loading with an incremental static force at an angle of 45 degrees to the long axis of the root. The other 50 samples underwent a pull-out test. Fracture failure strength and pull-out strength were measured and analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test (α=0.05). After the tests were completed, all specimens displayed oblique root fractures or cracks, initiating from the palatal cervical margin and propagating in a labial-apical direction. The order of the fracture failure strength was as follows: 5FC=CM=2FC>ML>DT. Cast metal posts demonstrated the highest pull-out strength (p<0.05). No significant differences in pull-out strength were found in the ML, 2FC, and 5FC groups. **Conclusion:** Within the limitations of this study, it was concluded that the application of an auxiliary fiber post could significantly increase the fracture resistance of over-flared roots; however, no beneficial effects in enhancing retention were observed. **PDF**

Li, Z, Wang, XZ, Gao, CZ, Ivo, K. **Fatigue and fracture resistance of the flared roots restored with computer aided design and computer aided manufacturing glass fiber posts].** *[Article in Chinese] Beijing Da Xue Xue Bao. 2013 Feb 18;45(1):59-63.*

Objective: To evaluate the fatigue and fracture resistance of the flared roots restored with computer aided design (CAD) and computer aided manufacturing (CAM) glass fiber posts. **Methods:** In the study, 32 maxillary central incisors with roots longer than 13 mm were selected and their canals were flared, and the roots were allocated into 4 groups (n=8) by a random number chart: CAD/CAM glass fiber posts, prefabricated quartz fiber posts, cast gold alloy posts, and CAD/CAM zirconia posts. The posts were luted to the roots by resin cement and fabricate zirconia crown for every specimen. An addition-type silicone impression material was used to simulate the periodontal ligament. All the specimens were submitted to 1.2×10(6) cycles loaded with a 49 N force, at 45 degree to the long axis of the teeth simultaneously with 3 000 thermal cycles (5 °C-50 °C-5 °C). After that, the specimens were subjected to a load at a crosshead speed of 1 mm/min in a servo-hydraulic testing machine applied at 45 degrees to the long axis of the tooth until fracture. The data were subjected to ANOVA test and the patterns of the failure were examined. **Results:** After the cycling loading, 4 crowns from prefabricated quartz fiber posts groups were deboned, and no other failure was found after the cycling loading; the fracture strengths of CAD/CAM glass fiber posts group [(441.5± 103.2) N] and cast gold alloy posts group [(462.9±170.0) N] were higher (F=4.613, P<0.05) than those of CAD/CAM zirconia posts group [(284.1±99.0) N] and prefabricated quartz fiber posts group [(315.4±112.3) N]; the entire specimens presented unfavorable failures. **Conclusion:** Although further in vitro and in vivo studies are necessary, the results of this study show that the use of CAD/CAM glass fiber posts and cast gold alloy posts may achieve better outcomes in flared roots than that of CAD/CAM zirconia posts and prefabricated quartz fiber posts.

Maceri, F, Martignoni, M, Vairo, G. **Optimal mechanical design of anatomical post-systems for endodontic restoration.** *Comput Methods Biomech Biomed Engin. 2008 Jul 16:1. [Epub ahead of print]*

This paper analyses the mechanical behaviour of a new reinforced anatomical post-systems (RAPS) for endodontic restoration. The composite restorative material (CRM) completely fills the root canal (as do the commonly used cast metal posts) and multiple prefabricated composite posts (PCPs) are employed as reinforcements. Numerical simulations based on 3D linearly elastic finite element models under parafunctional loads were performed in order to investigate the influence of the stiffness of the CRM and of the number of PCPs. Periodontal ligament effects were taken into account using a discretised anisotropic nonlinearly elastic spring

system, and the full discrete model was validated by comparing the resulting stress fields with those obtained with conventional restorations (cast gold-alloy post, homogeneous anatomical post and cemented single PCP) and with the natural tooth. Analysis of the results shows that stresses at the cervical/middle region decrease as CRM stiffness increases and, for large and irregular root cavities that apical stress peaks disappear when multiple PCPs are used. Accordingly, from a mechanical point of view, an optimal RAPS will use multiple PCPs when CRM stiffness is equal to or at most twice that of the dentin. This restorative solution minimizes stress differences with respect to the natural tooth, mechanical inhomogeneities, stress concentrations on healthy tissues, volumes subject to shrinkage phenomena, fatigue effects and risks of both root fracture and adhesive/cohesive interfacial failure. **PDF**

Maceri, F, Martignoni, M, Vairo, G. **Mechanical behaviour of endodontic restorations with multiple prefabricated posts: a finite-element approach.** *J Biomech. 2007;40(11):2386-98. Epub 2007 Jan 24*

This paper investigates some mechanical aspects of a new endodontic restoration technique, based on the idea that the root cavity can be more efficiently filled if multiple prefabricated composite posts (PCP) are employed. Multi-post technique increases bearing capacity and durability of endodontically treated teeth, as shown by numerical simulations performed through three-dimensional elastic finite-element static analyses of a lower premolar, constrained by a non-linearly elastic spring system representing the periodontal ligament, under several parafunctional loads. The influence of PCPs' number, material and dimensions is investigated by comparison of the resulting stress fields with those obtained in cases of traditional restorations (cast metal post and cemented single-PCP) and natural tooth, highlighting the advantages of the proposed technique when standard restorative materials are considered. A risk-analysis of root-fracture and interface-failure shows that cast gold-alloy post produces high stress concentrations at post-dentin interface, whereas multi-post solution leads to a behaviour closer to the natural tooth's, exhibiting some advantages with respect to single-PCP restorations. As a matter of fact, whenever PCPs' overall cross-section area increases, multi-post solution induces a significant reduction of stress levels into the residual dentin (and therefore the root-fracture-risk decreases) as well as of the expected polymerization shrinkage effects. Moreover, interfacial stress values in multi-post restorations can be higher than the single-PCP ones when carbon-fibre posts are considered. Nevertheless, the interfacial adhesive/cohesive failure-risk is certainly acceptable if glass-fibre posts are employed. **PDF**

Martelli, H Jr, Pellizzer, EP, Rosa, BT, Lopes, MB, Gonini, A. Jr. **Fracture resistance of structurally compromised root filled bovine teeth restored with accessory glass fibre posts.** *Int Endod J. 2008 Aug;41(8):685-92. Epub 2008 Jun 28.*

Aim: To evaluate the mechanical behaviour of structurally compromised root filled bovine roots after restoration with accessory glass fibre posts. **Method:** Fifty roots of bovine teeth received conventional post preparations with a cervical diameter of 3.5 mm. The roots were assigned to five groups (n = 10): group MP - cast metal post, group GP - glass fibre post and group AGP - glass fibre post plus accessory glass fibre posts. In groups GP-R and AGP-R (similar to groups GP and AGP), 2 mm of coronal tooth structure were left intact. All groups were subjected to an elastic limit assay and tested in an universal machine for fracture resistance. Repeated measures anova were performed to examine differences in fracture resistance; fracture modes were analysed by Fischer's exact test. **Results:** The mean fracture resistance values (kgf) were 61.8 (MP), 63.1 (GP), 55.5 (AGP), 56 (GP-R) and (53.1) AGP-R. No statistically significant difference was found between groups. The Fisher's exact test indicated significant differences ($P < 0.05$) in the fracture mode amongst groups MP, GP and AGP, indicating 100%, 50% and 10% of catastrophic fractures, respectively. **Conclusions:** The use of accessory glass fibre posts affected the fracture mode favorably: 90% of fractures in group AGP were in the coronal third. **PDF**

Moosavi, H, Maleknejad, F, Kimyai S. **Fracture resistance of endodontically-treated teeth restored using three root-reinforcement methods.** *J Contemp Dent Pract 2008 January; (9)1:030-037.*

Aim: The aim of this in vitro study was to compare the fracture resistance of endodontically-treated anterior teeth with their roots reinforced using three different restorative methods. **Methods and Materials:** Forty sound maxillary human central incisors were randomly assigned to four groups (n=10). The crowns of the teeth were removed at a level 2 mm incisal to the cementoenamel junction (CEJ). After root canal therapy, flared canals were simulated in three groups. In the first, second, and third groups the flared canals were reinforced with resin composite (RCO) (Clearfil DC Core Automix), two Reforpins (REF), and a resin cement (RCE) (Panavia F 2.0), respectively. In the fourth (DEN) group flared canals were not created. The same size fiber reinforced composite (FRC) posts were cemented with resin cement (Panavia F 2.0) in all groups. After post cementation and restoration of the teeth crown with a core build-up composite (Clearfil Photo Core), the roots of the teeth were embedded in acrylic resin blocks up to 1 mm below the CEJ. The samples were loaded in an Instron testing machine with a crosshead speed of 0.5 mm/min at a 45o angle to the long axis of the tooth on the palatal surfaces until failure occurred. Data were analyzed using the Kruskal-Wallis, Mann- Whitney, and Chi-square tests ($p=0.05$). **Results:** Significant differences were found between fracture resistance in all of the groups ($P<0.05$) with the exception being among the RCO and REF groups. The least mean value 230 (130) N and the highest mean value 830 (220) N were shown in the fracture resistance of the RCE and DEN groups, respectively. **Conclusion:** Reforpin can be used as an alternative to resin composite for internal reinforcement of weakened roots according to the results of this study. For reinforcement of flared canals, fiber posts along with Reforpin or resin composite proved to have higher fracture resistance than resin cement. Non flared canals had the highest fracture resistance. **PDF**

Parcina Amizic,I.,. Miletic, I, Baraba, A. Fan, Y., Nathanson, D . **In-vitro retention of prefabricated and individually formed posts..** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #1622, 2017(www.dentalresearch.org)*

Objectives: The aim of this study was to investigate the retention of prefabricated resin posts vs. individually formed fiber reinforced composite posts (FRC), cemented with self-adhesive cement. The null hypothesis was that both post systems would be equally retentive. **Methods**: Thirty extracted single-rooted human teeth were de-coronated, endodontically treated, and followed by post space preparations in equal lengths. All prepared specimens were randomly divided into two groups (n=15/each) according to the type of post: Group 1. "GC Fiber Post" (GC); Group 2. **"EverStick"** (GC), Individually formed resin & fibers posts. In both groups, G-CEM LinkAce (GC) was used for posts cementing. Each post was held with moderate pressure and tooth surfaces were light cured for 20 seconds (650mW/cm2). The exposed end of each post was coated with bonding agent (Schotchbond Universal) and fixed in hexagonal steel coupling nut filled with Z250 composite, leaving about 3 mm gap to the tooth surface. The composite was light cured (20s) around the nut end. Treated teeth were kept in water (24hrs) prior to pull out testing. Each specimen was subjected to a tensile force parallel to the longitudinal axis of the posts (Instron, x-head speed 0.5mm/min) until post separation. Data were statistically analyzed using T-Test and ANOVA (significance set at 5%). **Results**: Mean Separations force (Newton) and SD of post systems is presented in table below: **Conclusions**: Under the conditions of this study, prefabricated Fiber Posts exhibited significant higher retention forces and lower variance than EverStick posts.

*Porciani, P., Vano, M., Radovic, I, Goracci, C., Garcia-Godoy, F., Ferarri, M. **Fracture resistance of fiber posts: Combinations of several small posts vs standardized single post.** *Am J Dent 2008; 21: 373-376*

Purpose: To determine the fracture resistance of different sizes of standardized single fiber posts and the combinations of multiple small experimental posts. **Methods:** Single posts in 3 different sizes (1, 2 and 3 DT Light-Posts; RTD St Egreve, France) as control, and seven combinations of experimental small posts, reproducing the the sizes of several endodontic files were cemented in endodontic resin blocks. The combination of small posts were made combining 2-4 small posts so as to reach the the sizes of the standardized DT Light-Posts. The posts were loaded at an angle of 45degrees to the long axis of the block using a crosshead speed of 1 mm/min. until specimen failure. Ten posts/combinations were tested using one – way ANOVA., followed by Tamhane test for the *post hoc* comparison ($p<0.05$). **Results:** For the single posts, fracture resistance increased when increasing the diameter of the post. The use of multiple posts resulted in fracture resistance comparable to that of the single post in 2 of the 3 post diameters studied (DT1 and DT2). For the largest diameter studied (DT3), the use of multiple posts resulted in lower fracture resistances than did the single (DT3) post. **PDF**

Raposo, L.H.A. Silva, G. R., Santos-Filho, P.C.F., Soares, P.V., Soares, C.J. **Effect of posts and materials on flared teeth's mechanical behavior.** *J Dent Res. Vol 90 (Spec. Iss. A) Abstract #1862, 2011 (www.dentalresearch.org)*

Objectives: Assess the effect of different post systems and restorative techniques on stress-strain behavior and fracture resistance of flared roots. **Methods:** The coronary portion was removed from 105 bovine incisors, leaving a 15.0 mm root. After endodontic treatment samples were embedded in polystyrene resin and the periodontal ligament was simulated. The specimens were divided into 7 groups (n=15) and the roots of two reference groups were restored with cast post and core (CPC – G1) and fiber-glass post (FGP – G2). In the other groups, root canal were flared and restored with CPC (G3); FGP (G4); FGP and accessories FGP (G5); and FGP directly (G6) or indirectly (G7) rebased with accessories FGP and composite resin. All teeth were restored with all-metal crowns. Samples were submitted to mechanical fatigue (3x105 cycles of 50N). Strain-gauges were attached to the roots and strain values (μS) were obtained under a 100N load. Fracture resistance (N) was tested with a oblique load at a 0.5 mm/min cross-head speed. Data were analyzed with one-way ANOVA and Tukey HSD test ($p<0.05$). Failure mode was classified in accordance to the degree of dental structure destruction. Bi-dimensional finite element analysis was performed with representative models of each group, based on von Mises stress distribution criteria. **Results:** The results (N) were: G6- (867.9±198.1)a; G1- (859.9±199,2)a; G7- (847±112.2)a; G5- (842.7±174)a; G2- (627.1±119,8)b; G4- (625.3±164,3)b; G3- (620.2±164.2)b. There was no significant difference in the strains measured among groups, however, CPC increase catastrophic failures. Finite element analyses revealed higher stress concentration in CPC than in FGP, irrespective of restorative technique. **Conclusion:** Fiber-glass posts associated with composite resin or with accessory fiber-glass posts seem to be more indicated as alternative to cast post and core in flared roots, because of the lower risk of catastrophic failures and better stress distribution.

Rosa, R, Hwas, A, Melo, D, Valandro, LF, Kaizer, O. **Fracture strength of endodontically treated teeth restored with different strategies after mechanical cycling.** *Gen Dent. 2012 Mar-Apr;60(2):e62-8.*

The aim of this study was to analyze the fracture strength of endodontically treated teeth with different coronal restoration strategies after mechanical cycling. Thirty bovine teeth were randomly allocated into three groups (n = 10): Group 1, cast metal post and core; Group 2, glass fiber post with a composite resin core; Group 3, glass fiber post with a glass prefabricated core. For post cementation, an etch and rinse multistep adhesive system and resin cement were used. The specimens were submitted to mechanical cycling (106 cycles, 90 N, 4 Hz, 37 ± 1 degree C) and immediately loaded in a universal testing machine. The statistical analysis (one-way ANOVA) did not indicate a significant difference among the tested groups (Group 1 = 593.9 ± 128.7 N; Group 2 =

554.4 ± 213.3 N; Group 3 = 427 ± 104.8 N; P = 0.06). With regard to fracture patterns, all Group 1 specimens demonstrated catastrophic failures, while the specimens in Groups 2 and 3 demonstrated core or core/post failure. Despite the similar fracture strength observed in the tested groups, teeth restored with composite resin or glass prefabricated cores demonstrated favorable failure patterns compared to the cast metal post and core group. This study demonstrates that a glass prefabricated core can be an acceptable alternative for the reconstruction of endodontically treated teeth.

Saavedra, G.D.S.F.A., Zogheib, L., Komori, P.C.D.P., Borges, A.L.S. , TANGO, R.N., et al. **Resistance to compression of weakened roots submitted to root reconstruction.** *J Dent Res. Vol 90 (Spec. Iss. A) Abstract # 1121, 2011 (www.dentalresearch.org)*

Objective: This study evaluated, in vitro, the fracture resistance of human non-vital teeth restored with different reconstruction protocols. **Methods:** Forty human anterior roots of similar shape and dimensions were assigned to four groups (n=10), according to root reconstruction protocol: Group I (control): non weakened root with glass fiber post; Group II: root with resin composite by incremental technique and glass fiber post; Group III: root with accessory glass fiber posts and glass fiber post and Group IV: root with anatomic glass fiber post technique. Following post cementation and core reconstruction, the roots were embedded in chemically activated acrylic resin and submitted to fracture-resistance testing, with a compressive load at an angle of 45º in relation to the long axis of the root at a speed of 0.5 mm/min until fracture. All data were statistically analyzed with bilateral Dunnett test (5%). **Results:** Group I presented higher mean values of fracture resistance when compared to three experimental groups. Besides, the 3 experimental groups evaluated presented similar resistance to fracture when compared among them. None of the forms of root reconstruction with dental posts improved root strength, and the incremental technique was suggested as being the most recommendable, since the type of fracture that occurred allowed the dental remainder to be repaired. **Conclusion:** The results of this in vitro study suggest that the healthy remaining radicular dentin is more important to fracture resistance than the different root reconstruction protocols.

Salvio, L., Gonini,A. Jr. Moura, S.K.Chaves, MD. Lopes, MB **Resin cement and glass fibre accessories posts: photoelastic analysis.** *J Dent Res. Vol 88 (Spec. Iss. A) Abstract # 1840, 2009 (www.dentalresearch.org)*

Objective: This study assessed the stress generated by resin cement on the walls of the prepared root with or without insertion of principal and/or accessory pre-fabricated glass fibre posts through photoelastic technique. **Methods:** The specimens were made of photoelastic resin discs with an inner orifice (2 mm*f*Ö and 4 mm height). The specimens were sandblasted with aluminum oxide and coated with an adhesive layer (Scotchbond Multi-purpose), and photoactivated by 20s. The specimens were divided into 5 groups (n=5) according to section of post used: Group 1 (G1) (control) - cement resin BiFix, Group 2 (G2) -one principal glass fibre post (Reforpost), Group 3 (G3) - 1 principal and 2 accessory glass fibre posts (Reforpin) Group 4 (G4) -5 accessory posts. After polymerization the specimens were analysed and the visual representation of stress were measured through the program Image tool using the isocromatic ring of order 1. The data were converted into MPa through a proper equation and the data submitted to ANOVA and Tukey's test (5%). **Results:** G1 (3.48 °" 0.23) did not differ from G2 (3.27 °" 0.26), but both differ from G3 (2.82 °" 0.14) and G4 (2.80 °" 0.18), which did not differ among each other. **Conclusion:** The inclusion of accessories posts can contribute to reducing the contraction stress on the walls of the root canals.

*Sharafeddin, F, Alavi, AA, Zare, S **Fracture resistance of structurally compromised premolar roots restored with single and accessory glass or quartz fiber posts.** *Dent Res J (Isfahan). 2014 Mar;11(2):264-71.*

Background: Glass and quartz fiber posts are used in restoration of structurally compromised roots. Accessory fiber posts are recently introduced to enhance the fiber post adaptation. This study evaluated the effectiveness of glass versus quartz accessory fiber posts. **Methods:** In this experimental study, 40 mandibular premolar roots with similar dimension (radius of 3.5 ± 0.2 mm and length of 13 ± 0.5 mm) were selected and their root canals were flared until 1.5 mm of dentin wall remained. They were randomly assigned to four groups (n = 10) and restored as follows: Exacto glass fiber post (EX), Exacto glass fiber post + 2 Reforpin accessories (EXR), D. T. Light-Post (RTD, St Egreve, France) quartz fiber post (DT), and D. T. Light-Post quartz fiber post + 2 Fibercone (RTD, St Egreve, France) accessories (DTF). All posts were cemented with Duo-Link resin cement and the cores were built with the particulate filler composite. Following 1-week water storage, specimens were subjected to fracture loads in a universal testing machine. The maximum loads and failure modes were recorded and analyzed with the two-way analysis of variance (ANOVA) and Fisher's exact tests (α = 0.05). **Results:** The mean fracture resistance values (N) were 402.8 (EX), 378.4 (EXR), 400.1 (DT), and 348.5 (DTF). Two-way ANOVA test showed neither reinforcing method (P = 0.094), nor post composition (P = 0.462) had statistically significant differences on fracture resistance of the structurally compromised premolar teeth. Fisher's exact test also demonstrated no statistically significant difference regarding two variables (P = 0.695). Core fracture was the most common failure mode (62.5%). **Conclusion:** Glass and quartz fiber posts with or without accessories restored the weakened premolar roots equally. **PDF**

Singh, A, Logani, A, Shah, N. **An ex vivo comparative study on the retention of custom and prefabricated posts**. *J Conserv Dent. 2012 Apr;15(2):183-6.*

Aim: This study was designed to comparatively evaluate the effect of cyclic loading on the retention of custom-fabricated fiber-reinforced composite (CF-FRC), prefabricated metal, and glass fiber posts. Methods: Thirty mandibular first premolars decoronated at the CE junction were divided into three groups (n=10). Groups A, B, and C were restored using Para Post (Whale dent), Reforpost (Angelus), and CF-FRC post (Ribbond-THM), respectively. Five specimens from each group were subjected to cyclic loading. Tensile bond strength (TBS) was evaluated. **Results:** Pre-loading TBS values were statistically, significantly higher for all posts (P<0.05). Before and after loading, there was a significant difference between group C as compared to groups A and B. **Conclusions:** Cyclic loading reduced the retention of all posts but was comparatively lesser for the CF-FRC post. This system provides sufficient retention required for clinical success. **PDF**

Torabi, K., Fattahi, F. Fracture **resistance of endodontically treated teeth restored by different FRC posts: An in vitro study.** *Indian J Dent Res, 20(3), 2009 DOI: 10.4103/0970-9290.57359*

Background: Posts and cores are often required for restoration of pulpless teeth and to provide retention and resistance for a complete crown, but conventional posts may increase the root fracture. **Objective:** This study was performed to compare the root fracture resistance of extracted teeth treated with different fibers reinforced with composite posts and treated teeth with conventional post and core systems. **Methods:** Root canal therapy was performed for 50 mandibular first premolars. The coronal portion of each tooth was amputated, and five post and core systems (cast, polyethylene woven, glass, carbon, and quartz fiber posts) were compared. Acrylic resin blocks were used for mounting, using a layer of elastomeric impression material covering the roots. The load was applied axially and measured with a universal testing machine. **Results and Conclusion:** Significantly, cast posts and cores had a higher failure threshold including teeth fracture; whereas, fiber posts failure was due to core fracture, with or without fractures in coronal portion of posts. Difference in FRC posts did not provide any significant difference in the load failure and the mode of fracture.

Usumez, A, Cobankara, FK, Ozturk, N, Eskitascioglu, G, Belli, S**. Microleakage of endodontically treated teeth with different dowel systems.** *J Prosthet Dent. 2004 Aug;92(2):163-9*

Statement of problem: Several new esthetic dowel systems are available for the restoration of endodontically treated teeth, but little is known about how effectively these dowels seal the restored teeth. **Purpose**: The purpose of this in vitro study was to compare microleakage of 3 esthetic, adhesively luted dowel systems with a conventional dowel system. **Methods:** The root canals of 41 human intact single-rooted extracted teeth were prepared using a step-back technique. The teeth were randomly divided into 4 experimental groups (n=10), and 1 tooth served as a positive control. The de-coronated roots were obturated with gutta-percha using lateral condensation. Roots were restored with 1 of the following dowel systems according to the manufacturer's instructions: (1) stainless steel dowels (ParaPost), (2) glass fiber dowels (Snowpost), (3) resin-supported polyethylene fiber (Ribbond) dowels, or (4) zirconia dowels (Cosmopost). Using a fluid filtration method, coronal leakage of the specimens along the dowel space and root canal restorative material was measured. Fluid movement measurements were made at 2-minute intervals for 8 minutes to measure the presence of voids existing in the obturated canals, at 1 week, 3 months, and 6 months following dowel insertion. A repeated-measures analysis of variance (ANOVA) was used to analyze logarithmic transformations of data (time and dowel material) for significant differences. The Tukey HSD test and paired 2-tailed tests were used to perform multiple comparisons (alpha=.05). **Results**: The data indicated that the leakage values varied according to the dowel system used (P<.01). There was significant interaction between dowel systems and time of testing (P<.01). The sealing ability of zirconia dowels decreased over time (P<.01), but sealing abilities of stainless steel and resin-supported polyethylene fiber dowels remained constant (P>.05). The sealing ability of glass fiber dowels increased at 3 months (P=.032) and remained constant over the next 3 months (P=.758). Statistically, resin-supported polyethylene fiber and glass fiber dowels showed the lowest coronal leakage when compared with stainless steel and zirconia dowels at all time periods (P<.01). There were no significant differences between resin-supported polyethylene fiber and glass fiber dowels at any time period. The initial leakage measurement in zirconia dowel and stainless steel dowels were similar (P=.914), but became significantly different at 3 and 6 months (P<.01). **Conclusions:** Resin-supported polyethylene fiber dowels and glass fiber dowels tested exhibited less microleakage compared to zirconia dowel systems. The latter system should be further evaluated because of its unacceptable level of leakage, **PDF**

Zogheib, LV, Saavedra, Gde S, Cardoso, PE, Valera, MC, Araújo, MA. **Resistance to compression of weakened roots subjected to different root reconstruction protocols.** *J Appl Oral Sci. 2011 Nov-Dec;19(6):648-54.*

Objective: This study evaluated, in vitro, the fracture resistance of human non-vital teeth restored with different reconstruction protocols. **Methods:** Forty human anterior roots of similar shape and dimensions were assigned to four groups (n=10), according to the root reconstruction protocol: Group I (control): non-weakened roots with glass fiber post; Group II: roots with composite resin by incremental technique and glass fiber post; Group III: roots with accessory glass fiber posts and glass fiber post; and Group IV: roots with anatomic glass fiber post technique. Following post cementation and core reconstruction, the roots were embedded in chemically activated acrylic resin and submitted to fracture resistance testing, with a compressive load at an angle of

45º in relation to the long axis of the root at a speed of 0.5 mm/min until fracture. All data were statistically analyzed with bilateral Dunnett's test (α=0.05). **Results:** Group I presented higher mean values of fracture resistance when compared with the three experimental groups, which, in turn, presented similar resistance to fracture among each other. None of the techniques of root reconstruction with intraradicular posts imde occurred allowed the remaining dental structure to be repaired. **Conclusion**: The results of this in vitro study suggest that the healthy remaining radicular dentin is more important to increase fracture resistance than the root reconstruction protocol. **PDF**

VIII. MISCELLANEOUS / OVERVIEW / REVIEW ARTICLES

Ahmed, SN, Donovan, TE, Ghuman, T. **Survey of dentists to determine contemporary use of endodontic posts.** *J Prosthet Dent; 2016 Oct 27. pii: S0022-3913(16)30369-9. doi: 10.1016/j.prosdent.2016.08.015. [Epub ahead of print]*

Statement of problem: Although the scientific literature provides sound decision-making tools for the restoration of endodontically treated teeth, dentists have different opinions on the rationale for the use of endodontic posts (dowels) and selection of post systems. The decision to place a post is at times contrary to the literature. Updated information on the treatment of endodontically treated teeth among general dentists is lacking. **Purpose:** The purpose of this survey was to gain insight into the rationale for choice of endodontic posts and the different endodontic post systems currently used by dental practitioners. Post and core restorations distribute stress and replace missing tooth structure in endodontically treated teeth. Guidelines exist to help select post systems. With the advent of new materials, prefabricated posts have gained popularity among dentists. However, cast-metal post-and-core systems are still considered the gold standard. **Material and methods:** Surveys were distributed to dentists attending continuing education meetings in the United States, Canada, Scotland, Ireland, and Greece. The questions addressed years of practice, specialty training, and brand, type, shape, and material of the endodontic post systems used. **Results:** Descriptive statistical analysis was used to assess the percentage of respondents. Ninety-two percent of the participants were general practitioners with 25.94 ±13.35 years of experience. The majority agreed upon using endodontic posts when insufficient coronal tooth structure remains and for stress distribution. Passive, parallel posts were the most commonly reported type and shape. With regard to post material, fiber posts were the most frequently used (72.2%), followed by prefabricated alloys (38.6%), cast-metal posts (33.9%), prefabricated titanium posts (30.1%), and stainless-steel posts (21.7%). For cementation, resin-modified glass ionomer (40%) was most frequently used, followed by self-adhesive resin (29.6%). **Conclusions:** The majority of the practitioners used fiber posts. This may be because, in terms of fracture, they compare favorably with cast-metal post and core, although little evidence in the literature validates this claim.

AL-Omiri ,M. K., Abdelaziz Mahmoud , A., Ramadan Rayyan , M., Abu-Hammad, O. **Fracture resistance of teeth restored with post-retained restorations: An Overview.** *Journal of Endodontics Volume 36, Issue 9 , Pages 1439-1449, September 2010*

Introduction: Posts have been used efficiently to retain restorations for badly destructed teeth. This article critically analyzes the concerned topics related to the fracture resistance of teeth restored with dowel-retained restorations. **Methods:** A systematic review of PubMed/MEDLINE, Cochrane, and Scopus databases was completed (from 1960 to 2010). Single or combined key words were used to obtain the most possible comprehensive list of articles. Checking the references of the relevant obtained sources completed the review along with a manual search to locate related articles on the topic. *In vivo* and *ex vivo* (laboratory, computer-based finite element, and photoelastic stress analysis studies) investigations related to the topic were included. **Results:** Many factors have been proposed to influence the fracture resistance of post-restored teeth. Recognizing the significance of these factors on the fracture resistance of teeth would aid in choosing the suitable treatment modality for every individual case. Fracture resistance was improved if tooth structure loss was limited, a ferrule was obtained, a post with similar physical properties to natural dentine was used, and adhesive techniques for post luting and coronal restoration were used. Adhesively luted resin/fiber posts with composite cores appear to be the best currently available option in terms of tooth fracture and biomechanical behaviour. **Conclusions:** Most guidelines were based mainly on *ex vivo* studies and to a lesser extent on limited *in vivo* studies. The lack of long-term controlled randomized clinical studies was the main hindrance to reaching a conclusive and undisputable opinion regarding endodontic posts in terms of tooth fracture and biomechanical behaviour.

Bitter, K, Kielbassa, AM. **Post-endodontic restorations with adhesively luted fiber-reinforced composite post systems: a review.** *Am J Dent. 2007 Dec;20(6):353-60*

Purpose: To review the literature on adhesive luting of fiber-reinforced composite posts (FRC) to provide evidence for the clinical procedure of restoring endodontically treated teeth using FRC posts. **Methods:** Data focusing on bonding behavior between root canal dentin, luting agent, and FRC post in vitro as well as in vivo performance of teeth restored with FRC posts were reported. These data were identified by searches of "PubMed", "Scopus", and "Cochrane Library" databases with the terms "post-endodontic restoration", "fiber post", "adhesive luting", "root canal dentin", "clinical study", and "pre-treatment fiber post". Papers published up to September 2007 were selected, and most relevant references were chosen. Cross-referencing of significant papers identified additional relevant articles. **Results:** FRC posts seem to have become increasingly popular for the restoration of endodontically treated teeth. Compared to metal posts, FRC posts revealed reduced fracture resistance in vitro, along with a usually restorable failure mode. Bonding behavior among FRC post, luting agents, and root canal dentin demonstrated varying results.

Bond strengths between FRC posts and resin cements can be enhanced by using various pre-treatment procedures; however, bonding to root canal dentin still seems to be challenging. Most clinical studies investigating survival rates of teeth restored with FRC posts revealed promising results, but risk factors (e.g., the loss of coronal tooth structure) have not been studied intensively. In addition, randomized controlled clinical long term trials are scarce.

Bitter, K, Perdigão, J, Exner, M, Neumannm K, Kielbassam A, Sterzenbachm G. **Reliability of fiber post bonding to root canal dentin after simulated clinical function in vitro.** *Oper Dent. 2012 Jul-Aug;37(4):397-405. Epub 2012 Feb 16.*

The aim of this study was to investigate the effect of thermomechanical loading (TML) on the bond strength of fiber posts luted with three different resin cements. Sixty-six extracted human anterior teeth were endodontically treated and restored with fiber posts (RelyX Fiber Posts, 3M ESPE) using three commercially available resin cements and three corresponding core build-up materials (n=22 each): Panavia F 2.0/Clearfil DC Core Automix (Kuraray), Variolink II/Multicore Flow (Ivoclar Vivadent), and RelyX Unicem/Filtek Z250 (3M ESPE). Twelve specimens of each group received all-ceramic crowns and were subjected to TML. The other 10 specimens were stored in saline solution for 24 hours. The roots were sectioned and bond strength was measured using a push-out test. Adhesive interfaces of two specimens of each group subjected to TML were analyzed using field emission scanning electron microscopy (FESEM). Bond strengths of fiber posts were significantly affected by the type of resin cement ($p<0.0005$) and TML ($p<0.0005$; two-way analysis of variance). TML significantly reduced bond strengths for all materials ((6.0 (6.2) MPa)) compared with initial bond strengths ((14.9 (10.4) MPa)). RelyX Unicem resulted in significantly higher bond strengths before ((18.3 (10.3) MPa)) and after TML ((9.8 (7.5) MPa)) compared with the other materials ($p<0.0005$; Tukey HSD). Using FESEM, Variolink II and Panavia F demonstrated a hybrid layer partly detached from the underlying resin cement, whereas no hybrid layer was observed for RelyX Unicem. The decrease in bond strength after TML suggests that retention of fiber posts may be reduced after clinical function. Therefore, endodontically treated teeth that are restored using fiber posts may benefit from additional reinforcement via coronal restorations using adequate ferrules and/or adhesive techniques.

Bitter, K, Schubert, A, Neumann, K, Blunck, U, Sterzenbach, G,, Rüttermann, S. **Are self-adhesive resin cements suitable as core build-up materials? Analyses of maximum load capability, margin integrity, and physical properties.** *Clin Oral Investig. 2015 Oct 8. [Epub ahead of print]*

Objectives: The aim of the present study was to test a self-adhesive resin cement used as core build-up material in comparison to two commercially available core build-up materials. **Methods:** Forty human anterior teeth were endodontically treated and fiber post insertion (RelyX Fiber posts) and core build-ups were performed using two core build-up materials applied with an etch-and-rinse adhesive approach (Luxacore Dual-LC and Clearfil Core-CC) and an experimental self-adhesive resin cement (SAR) in two application modes (SAR Handmix and SAR Automix). Samples were subjected to thermo-mechanical loading. Margin integrity was determined using scanning electron microscopy (SEM), and maximum load capability (Fmax) was evaluated. Physical properties of the tested materials were also examined. **Results:** Fmax was significantly affected by the core build-up material ($p < 0.0005$; one-way ANOVA). CC [481 (158) N] revealed significantly higher Fmax compared to LC [226 (80) N], SAR Hand [205 (115), and SAR Automix [197 (134) N] ($p < 0.05$; Tukey-B). The percentage of margin quality "continuous margin" in enamel after thermo-mechanical loading (TML) differed significantly among groups ($p < 0.0005$; Kruskal-Wallis); CC demonstrated a significantly higher percentage of margin quality "continuous margin" compared to the other groups. Physical properties were significantly affected by the different core materials ($p < 0.0005$; ANOVA); CC and LC demonstrated significantly higher flexural strength compared to both SAR groups as well as significantly higher water sorption of both SAR groups compared to CC and LC. **Conclusion:** Within the limitations of the present in vitro study, we conclude that the investigated experimental self-adhesive resin cement is not suitable as a core build-up material due to the lower maximum load capability, low margin quality, and the data of the mechanical properties.The investigated experimental self-adhesive resin cement cannot be recommended as a core build-up material.

Boksman, L., Pameijer, C., Broome, J. **The clinical significance of mechanical properties in retentive posts.** *Compendium, June 2013, Vol35, No. 6 446-455*
When selecting dental materials for use in the permanent restoration of severely broken down teeth, clinicians must choose a material with the optimal mechanical and physical properties for that particular application, with esthetics as a secondary consideration. As the trend in dentistry shifts towards fiber-reinforced composite endodontic posts and away from metal posts, this article reviews how fiber posts differ from their metal predecessors and how they vary intrinsically from one design and composition to another. Additionally, the article examines how fiber posts actually function and interact with the tooth

Boksman, L., Glassman, G., Coelho-Santos, G., Friedman, M., **Fiber posts and tooth reinforcement; Evidence in the literature**. *Oral Health, May 2013, 32-47*

In addition to the traditional definition of mechanical reinforcement: restoring a compromised tooth to a fracture strength equal to or greater than its original “untreated” fracture resistance, we clinicians perhaps should be more focused on the predictability of outcomes, particularly in worst-case scenarios. That is the contribution of the post versus no post, or composite only, to the remaining structures. The most predominant conclusion emerging from the growing body of in vitro (and clinical) data is that failures of fiber posts in situ are more likely to be described as “non-catastrophic” or “repairable” which is usually not the case with high modulus posts.

*Brown, P., Hicks, N., **Rehabilitation of endodontically treated teeth using the radiopaque fiber post.** *Compendium Vol. 24, No. 4, April, 2003, 275-282*

Metallic posts fall short of satisfying contemporary guidelines for ideal post / core rehabilitation. Along with technological advancements in adhesive resin cements and composite restoratives, the evolution of fiber-reinforced posts allows the rehabilitation of endodontically treated teeth with greater esthetics anv virtually no predisposition to root fracture. At least one fiber post system now complies with all of the ideal post characteristics described in the endodontic text. This article describes the potential for displacement of metal posts by low-modulus fiber posts, the differences between them and the development and clinical placement of a radiopaque, translucent, double-tapered fiber post. **PDF**

Christensen, G. J. **Post concepts are changing,** *JADA, Vol. 135 Sept., 2004, 1306-1310*

Recently there is a clearly observable movement toward use of fiber-reinforced resin-based composite posts used in conjunction with composite build-ups. The resin-cemented fiber posts, followed by composite build-ups were as strong as the metal posts used with composite build-ups. They do NOT impart any objectionable color to the tooth. In terms of most of the necessary post characteristics, the fiber posts are superior to metal prefabricated posts. They are easy to place, are relatively inexpensive, can be bonded to resin cement, and are easy to remove if the tooth needs to be retreated endodontically. **PDF**

*De Rijk, W., Pecora, N. **Effects of cutting methods on fiber posts, SEM evaluation**. *J Dent Res. Vol 86 (Spec. Iss. A) Abstract #2700, 2007 (www.dentalresearch.org)*

Objectives: Prefabricated fiber posts, used in the restoration of endodontically treated teeth, routinely require a reduction in length, to accommodate the individual patient. This study evaluated the effect of trimming fiber posts with either a diamond bur or a diamond disk. **Methods:** Five different post systems: 1) CF Carbon fiber post (J. Morita USA Inc), 2) DT Light-Post (Bisco / RTD St Egreve France.), 3)FRC Postec (Ivoclar Vivadent) Parapost FW (Coltene Whaledent), 5)Twin Lucent (Dentatus USA), were trimmed with either a diamond bur (8862) or a diamond disk (911HF, Brasseler USA). Two different core systems were used CompCore AF (Premier) and Light Core (Bisco Inc). The posts were cut, once through the core material and once at 3mm above the apical end. The cut surfaces were then evaluated by SEM. The surfaces showed various degrees of resin loss between the fibers. Two investigators estimated the total surface area with resin loss. **Results:** The observed surface area (in %) with resin loss is listed. No differences were observed between the two core materials, hence all core data have been combined. **Conclusions:** From these data we conclude that: 1) the use of a diamond disk produces less resin loss from the fiber post, when compared to a diamond bur, and 2) that for those fiber posts, for which by design the coronal part of the post is to be trimmed, the post should be trimmed after the post and the core material have been placed. The materials for this study have been provided by the various manufacturers, and their support is hereby acknowledged.

Dietschi, D., Romelli, M., and Goretti, A. **Evaluation of post and cores in the laboratory: Rationale for developing a fatigue test and preliminary results.** *Compendium. 17: S65-S73, 1996.*

Abstract/conclusions: Prosthetic treatment failures related to the biomechnical deficiencies of post and cores still represent a problem of clinical significance. To overcome the difficulties of clinical studies, numerous in vitro methods were developed to address specific properties of post-and-core restorations. Most of them, however, were based on an oversimplified mechanical testing of the restored tooth. Experience proved that the fatigue of the restored materials was a primordial factor in clinical failures. Therefore, special devices were built that simulate the physiological masticatory cycle. Tests performed with adhesive post-and-core systems seem to indicate that materials placed in the tooth should have physical properties as close as possible to those of natural tissues. New carbon-epoxy posts (Composipost) appear to offer a promising solution for restoring the endodontically treated tooth. **PDF**

Dietschi, D., Duc, O., Krejci, I., Sadan, A. **Biomechanical considerations for the restoration of endodontically treated teeth: A systematic review of the literature-Part 1**. **Composition and macro-structure alterations**. *Quintessence Int 2007; 38:733-743.*

The specific biomechanical alterations related vitality loss or endodontic procedures are confusing issues for the practitioner and have been controversially approached from a clinical standpoint. The aim of part 1 of this literature review is to present an overview of the current knowledge about composition changes, structural alterations, and status following endodontic therapy and restorative procedures. The basic search process included a systematic review of the PubMed/Medline database between 1990 and 2005, using single or combined key words to obtain the most comprehensive list of references; a perusal of the references of the relevant sources completed the review. Only negligible alterations in tissue moisture and composition attributable to vitality loss or endodontic therapy were reported. Loss of vitality followed by endodontic therapy proved to affect tooth biomechanical behavior only to a limited extent. Conversely, tooth strength is reduced in proportion to coronal tissue loss, due to either caries lesion or restorative procedures. Therefore the best current approach for restoring endodontically treated teeth seems to (1) minimize tissue

coronal levels to strengthen remaining tooth structure and optimize restoration stability and retention, and (3) use post and core materials with physical properties close to those of netural dentin, because of the limitations of current adhesive procedures.

Dietschi, D, Duc, O, Krejci, I, Sadan, A. **Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies.** *Quintessence Int. 2008 Feb;39(2):117-29*

Objective: The restoration of endodontically treated teeth has long been guided by empirical rather than biomechanical concepts. Part I of this literature review presented up-to-date knowledge about changes in tissue structure and properties following endodontic therapy, as well as the behavior of restored teeth in monotonic mechanical tests or finite element analysis. The aim of the second part is to review current knowledge about the various interfaces of restored, nonvital teeth and their behavior in fatigue and clinical studies. **Review method:** The basic search process included a systematic review of articles contained in the PubMed/Medline database, dating between 1990 and 2005, using single or combined key words to obtain the most comprehensive list of references; a perusal of the references of the references completed the review. **Conclusions:** Nonvital teeth restored with composite resin or composite resin combined with fiber posts resisted fatigue tests and currently represent the best treatment option. In comparison to rigid metal and/or ceramic posts, when composite resin or composite resin/fiber posts fail, the occurrence of interfacial defects or severe tooth breakdown is less likely. Adhesion into the root, however, remains a challenge because of the unfavorable ovoid canal configuration, as well as critical dentin microstructure in the deepest parts of the canal. Thus, specific combinations of adhesives and cements are recommended. The clinical performance of post-and-core restorations proved satisfactory overall, in particular with a contemporary restorative approach using composite resin and fiber posts. However, the clinical literature does not clearly isolate or identify exact parameters critical to success. This, in turn, emphasizes the importance and relevance of in vitro studies to further improve the quality and long-term stability of prosthetic foundations. **PDF**

Faria, ACL, Rodrigues, RCS, et al. E**ndodontically- treated teeth: Characteristics and considerations to restore them** . *J Prosthetic 55 (2011) 69-74. Review article.*

The restoration of endodontic pretreated teeth is a topic that is extensively studied and yet remains controversial. This article emphasizes the characteristics of endodontic Lee treated teeth and some principles to be observed when restorations of these teeth are planned. It was concluded that the amount of remaining coronal to structure and functional requirements determine the best way to restore these teeth, indicating the material to be used, direct or indirect restorations, associated or not to posts. **PDF**

Ferrari, M, Mannocci, F. **A one-bottle adhesive system for bonding a fibre post into a root canal: an SEM evaluation of the post-resin interface.** Int. Endodontic Journal, *33, 397-400, 2000.*

Abstract / conclusions: This report presents a case in which a “one-bottle” adhesive system (ONE-STEP) was used in combination with proprietary resin cement for bonding a fibre post. The fibre post was placed into the root canal of a fractured root under clinical conditions and then extracted 1 week later. Using Scanning Electron Microscopy, half of the root was evaluated for hybrid layer formation and the other half for assessing resin tags. The investigation demonstrated that the one-bottle system can infiltrate and create a mechanical interlocking with etched root dentine. **PDF**

Glazer, B. **Endodontic post evolution: from metal to quartz** *Oral Health, May, 2002 43-45*

Abstract/conclusions: The Light-Post is a 15-year evolution of post research at RTD. Its genesis began with the carbon fiber Composipost/ C-POST, transformed into the AesthetiPlus, made of white quartz fiber, and finishing with the Light-Post, made of translucent quartz fiber. This transition from Carbon to Quartz was completed without any compromise in strength, modulus of elasticity, resistance to fatigue or the ability for re-treatment. The Light-Post offers clinicians significant aesthetic and clinical advantages due to its translucency. **PDF**

Goodacre, CJ., **Carbon fiber posts may have fewer failures than metal posts**. *J Evid Based Dent Pract. 2010 Mar;10(1):32-4.*

Selection criteria: The authors searched MEDLINE, EMBASE, CENTRAL, and Scopus electronic databases through 2004 for eligible articles. The authors also searched International Association for Dental Research conference proceedings and abstracts from 1996-2004 and contacted manufacturers and other known experts to identify unpublished studies. Studies had to be randomized or quasi-randomized clinical trials (RCT) evaluating failures of endodontically-treated permanent teeth with different post types. This systematic review included one clinical study related to answering the primary objective, and this study involved 200 patients, 100 receiving a fiber post and 100 receiving a cast metal post. A second clinical study was included as related to a secondary objective and that study involved 117 patients, with 60 receiving a composite resin restoration as the definitive treatment

after placement of a fiber post and 57 receiving a complete coverage metal ceramic crown as the definitive treatment after a fiber post had been placed. K**ey study factor**: The primary treatment of interest was the type of post used, metal versus non-metal. A secondary interest was the prosthetic status of the tooth, carbon fiber post followed by a composite resin restoration versus a carbon fiber post followed by a metal ceramic crown. **Main outcome measure:** The main measure used to evaluate treatment effectiveness for the primary objective (metal versus non-metal post) and the secondary objective (composite resin definitive restoration versus metal ceramic crown) was post failure. MAIN Results: Regarding the study addressing the primary objective, the fiber post resulted in fewer failures (0/97) than the conventional cast post and core system (9/98) after 4 years of clinical service. The risk ratio (RR) = 0.05, and there was a 95% confidence interval (CI) of 0.00 to 0.90. This study was judged to be at high risk of bias. Root fracture was the only failure encountered in the cast post and core group. **Conclusions:** The results suggest fiber posts may be more successful than cast metal posts, but there were not enough RCTs to warrant a definitive recommendation.

Goracci C, Grandini S, Bossù M, Bertelli E, Ferrari M. **Laboratory assessment of the retentive potential of adhesive posts: a review.** *J Dent. 2007 Nov;35(11):827-35*

Objectives: This review aimed at summarizing the laboratory evidence collected on the retentive ability of adhesive posts since their introduction in dentistry. **Data:** Data were searched in articles published or in press in peer-review journals listed in MEDLINE. **Sources:** Papers were retrieved through PubMed. **Study selection:** To collect the evidence of interest, the following search terms were used: bond* AND fiber post AND in vitro; lut* AND fiber post AND in vitro; push-out AND fiber post; pull-out AND fiber post; microtensile AND fiber post. "Related Links" were also considered and articles cited in the initially retrieved papers were included if relevant. No time limit was given to the query. **Conclusions:** Seventy relevant papers were reviewed. The retentive ability of adhesive posts has been tested with the microtensile technique, post-pull-out and push-out tests. If small-sized specimens are obtained, such as in microtensile and thin-slice push-out, stress uniformity is favoured, local differences in bonding conditions can be discerned, and the number of teeth needed for the test can be reduced. Although adhesion to intraradicular dentin is more challenging to achieve than bonding to crown tissues, the post-retention achieved with current luting systems and techniques is adequate to ensure the clinical success of adhesive post-retained restorations. To enhance the bond at the post-core and post-cement interfaces, several chemical pre-treatments of the post-surface have been tested with positive results. Self-adhesive resin cements, recently proposed to simplify the post-luting procedure, should be investigated further with regard to durability.

Juloski, J, Radovic, I, Goracc,i C, Vulicevic, ZR, Ferrari, M. **Ferrule effect: a literature review**. *J Endod. 2012 Jan;38(1):11-9. Epub 2011 Nov 13.*

Preserving intact coronal and radicular tooth structure, especially maintaining cervical tissue to create a ferrule effect, is considered to be crucial for the optimal biomechanical behavior of restored teeth. The ferrule effect has been extensively studied and still remains controversial from many perspectives. The purpose of this study was to summarize the results of research conducted on different issues related to the ferrule effect and published in peer-reviewed journals listed in PubMed. Methods: The search was conducted using the following key words: ‘‘ferrule’’ and ‘‘ferrule effect’’ alone or in combination with ‘‘literature review,’’ ‘‘fracture resistance,’’ ‘‘fatigue,’’ ‘‘finite element anal- ysis,’’ and ‘‘clinical trials.’’ Results: The findings from re- viewed articles were categorized into three main categories: laboratory studies, computer simulation, and clinical trials. Laboratory studies were further classi- fied into subchapters based on the main aspect investi- gated in relation to the ferrule effect. Conclusions: The presence of a 1.5- to 2-mm ferrule has a positive effect on fracture resistance of endodontically treated teeth. If the clinical situation does not permit a circumferential ferrule, an incomplete ferrule is considered a better option than a complete lack of ferrule. Including a ferrule in preparation design could lead to more favorable frac- ture patters. Providing an adequate ferrule lowers the impact of the post and core system, luting agents, and the final restoration on tooth performance. In teeth with no coronal structure, in order to provide a ferrule, orthodontic extrusion should be considered rather than surgical crown lengthening. If neither of the alter- native methods for providing a ferrule can be performed, available evidence suggests that a poor clinical outcome is very likely.

Kishen, A., Kumar, GV, Chen N-N. **Stress-strain response in human dentine: rethinking fracture predilection in post-core restored teeth**. *Dent Traumatol 2004; 20: 90-100.*

In this study, the bio-mechanical perspective of fracture predilection in post-core restored teeth is investigated using computational, experimental, and fractographic analyses. The computational finite element analysis and the experimental tensile testing are used to evaluate the stress-strain response in structural dentine. The fractal graphic evaluations are conducted using laser scanning confocal microscopy and standing electron microscopy to examine the topography of dentine from experimentally fractured specimens, and clinically fractured post-core restored teeth specimens. These experiments aided in correlating the stress-strain response in structural dentine is with cracks and catastrophic fractures in post-core restored teeth. it was observed from these experiments that the inner dentine displayed distinctly high strains (deformations), while the outer dentine demonstrated higher stresses during tensile loading. This implies that the energy fed into the material as it is extended will be spread throughout the inner dentine and there is less possibility of local increase in stress at the outer dentine, which can lead to the failure of dentine structure. During post-endodontic restoration with increase in loss of inner dentine, the fracture resistance factor contributed by the inner dentine is compromised, and this in turn predisposes the tooth to catastrophic fracture. Conclusion: Undo loss or removal of the inner dentine, because of pathologic processes or during post and core restoration would compromise the toughness

criteria in dentine structure, which in turn would predispose such tooth structure to catastrophic fractures. Furthermore, application of a morphologically designed post and core, that minimizes extensive excessive removal of inner dentine, and the use of adhesive dental restorations are recommended to reinstate the natural stress-strain response in dentine structure **.PDF**

Lamichhane, A, Xu, C, Zhang, FQ. **Dental fiber-post resin base material: a review.** *J Adv Prosthodont. 2014 Feb;6(1):60-5. doi: 10.4047/jap.2014.6.1.60. Epub 2014 Feb 14.*

Teeth that have short clinical crown, which are not alone enough to support the definitive restoration can be best treated using the post and core system. The advantages of fiber post over conventional metallic post materials have led to its wide acceptance. In addition to that the combination of aesthetic and mechanical benefits of fiber post has provided it with a rise in the field of dentistry. Also the results obtained from some clinical trials have encouraged the clinicians to use the fiber posts confidently. Fiber posts are manufactured from pre-stretched fibers impregnated within a resin matrix. The fibers could that be of carbon, glass/silica, and quartz, whereas Epoxy and bis-GMA are the most widely used resin bases. But recently studies are also found to be going on for polyimide as possible material for the fiber post resin base as a substitute for the conventional materials. **PDF**

Manhart, J. **Fabricating fiber-reinforced composite posts.** *Dent Today. 2011 Mar;30(3):84, 86, 88-92.*

Endodontic posts do not increase the strength of the remaining tooth structure in endodontically treated teeth. On the contrary, depending on the post design employed (tapered versus parallel-sided), the root can be weakened relative to the amount of tooth removed during preparation. In many cases, if there has been a high degree of damage to the clinical crown, conservative preparation for an anatomic tapered (biomimetic) post with the incorporation of a ferrule on solid tooth structure is necessary to protect the reaming root structure as well as for the long-term retention of the composite resin core and the definitive restoration. Adhesively luted endodontic posts reinforced with glass or quartz fiber lead to better homogeneous tension distribution when loaded than rigid metal or zirconium oxide ceramic posts. Fiber-reinforced posts also possess advantageous optical properties over metal or metal oxide post systems. The clinician should realize that there are admittedly substantial differences in the mechanical loading capacity of the different fiber-reinforced endodontic posts and should be aware of such differences in order to research and select a suitable post system for use.

*Pitel, M. L., Hicks, N. L. **Evolving technology in endodontic posts**. *Compendium 24 13-29, 2003*

Abstract/conclusions: This article provides a brief overview of important, recent changes in the philosophy, materials and technology that have impacted significantly on the art and science of endodontic post placement. The growing interest in esthetic dental restorations and adhesion dentistry has driven both manufacturers and dentists to create some innovative new post materials and techniques for restoring the endodontically treated tooth. Although metal posts were used extensively for many years, their popularity is currently in the decline. With more than 10 years of proven clinical success, there is now widespread interest in the use of non-metallic post materials and techniques. Over the last decade, in vitro and in vivo testing has demonstrated that some fiber-reinforced endodontic posts can dramatically reduce the incidence of root fracture, tissue discoloration and allergic reaction. If endodontic re-treatment is necessary, most fiber posts can be removed from a root canal with ease and predictability when necessary without compromising their only true function; core retention. Today's marketplace offers the dentist many choices in size, radiopacity and designs to fit the needs of the specific tooth and clinical application. The use of a highly translucent post not only can serve to enhance esthetics in the final restoration, but can also be useful as an instrument in the light-curing process. **PDF**

de Melo, RM, Chaves, C, Galhano, GA, Bottino, MA, Balducci, I. **The adhesive system and root canal region do not influence the degree of conversion of dual resin cement.** *J Appl Oral Sci. 2010 Sep-Oct;18(5):477-81*

Objectives: The aim of this study was to evaluate the influence of two adhesive systems and the post space region on the degree of conversion of dual resin cement and its bond strength to root dentin. **Methods:** One three-step etch-and-rinse (All-bond 2, Bisco Dental, Schaumburg Il, USA) and another one-step self-etch (Xeno III, Dentsply) adhesive systems were applied on 20 (n=10) crownless bovine incisors, at 12-mm-deep post space preparation, and a fiber post (DT Light Post, RTD, St Egreve France / Bisco) was cemented using a dual cure resin cement (Duo-Link, Bisco). Three transverse sections (3 mm) were obtained, being one from each study region (cervical, middle and apical). The degree of conversion of the dual cure resin cement was determined by a micro-Raman spectrometer. The data (%) were submitted to repeated-measures analysis of variance and Tukey's test ($p<0.05$). **Results:** For both groups, the degree of conversion means (%) (All bond 2cervical = 69.3; All bond 2middle = 55.1; All bond 2apical= 56; Xeno IIIcervical = 68.7; Xeno IIImiddle = 68.8; Xeno IIIapical = 54.3) were not significantly different along the post space regions ($p<0.05$). **Conclusion:** Neither the adhesive nor the post space region influenced the degree of conversion of the cement layer.

Poskus, LT, Sgur,a R, Paragó, FEM, Silva, EM, Guimarães, JGA. **Influence of post pattern and resin cement curing mode on the retention of glass fibre posts.** International Endodontic Journal, 43, 306–311, 2010.

Aim: To evaluate the influence of post design and roughness and cement system (dual- or self-cured) on the retention of glass fibre posts. **Methods:** Two tapered and smooth posts (Exacto Cônico No. 2 and White Post No. 1) and two parallel-sided and serrated posts (Fibrekor 1.25 mm and Reforpost No. 2) were adhesively luted with two different resin cements – a dual-cured (Rely-

X ARC) and a self-cured (Cement Post) – in 40 single-rooted teeth. The teeth were divided into eight experimental groups (n = 5): PFD – Parallel-serrated-Fibrekor/dual-cured; PRD – Parallel-serrated-Reforpost/dual-cured; TED – Tapered-smooth-Exacto Cônico/dual-cured; TWD – Tapered-smooth-White Post/dual-cured; PFS – Parallel-serrated-Fibrekor/self-cured; PRS – Parallel-serrated-Reforpost/self-cured; TES – Tapered-smooth-Exacto Cônico/self-cured; TWS – Tapered-smooth-White Post/self-cured. The specimens were submitted to a pull-out test at a crosshead speed of 0.5 mm min^{-1}. Data were analysed using analysis of variance and Bonferroni's multiple comparison test ($\alpha = 0.05$). **Results:** Pull-out results (MPa) were: PFD = 8.13 (±1.71); PRD = 8.30 (±0.46); TED = 8.68 (±1.71); TWD = 9.35 (±1.99); PFS = 8.54 (±2.23); PRS = 7.09 (±1.96); TES = 8.27 (±3.92); TWS = 7.57 (±2.35). No statistical significant difference was detected for posts and cement factors and their interaction. **Conclusions:** The retention of glass fibre posts was not affected by post design or surface roughness nor by resin cement-curing mode. These results imply that the choice for serrated posts and self-cured cements is not related to an improvement in retention.

Ree, M., Schwartz, R. **The Endo-restorative interface; Current concepts**, *Dent Clin N Am 54 (2010) 345–374 doi:10.1016/j.cden.2009.12.005*

The primary goals of endodontic treatment are straightforward: to debride and disin- fect the root canal space to the greatest possible extent, and then seal the canals as effectively as possible. The materials and techniques change somewhat over time, but not the ultimate goals. The primary goals of restorative treatment are to restore teeth to function and comfort and in some cases, aesthetics. Once again, the materials and techniques change, but not the ultimate goals of treatment. Successful endodontic treatment depends on the restorative treatment that follows. The connection between endodontic treatment and restorative dentistry is well accepted, but the best restor- ative approaches for endodontically treated teeth have always been somewhat controversial. The topic is no less controversial today, despite the massive (and ever growing) amount of information available from research, journal articles, courses, ‘‘expert’’ opinions, and various sources from the Internet. In fact, information overload contributes to the controversy because so much of it is contradictory. With the emergence of implants into the mainstream of dentistry, there has been more emphasis on long-term outcomes and on evaluating the ‘‘restorability’’ of teeth prior to endodontic treatment. Patients are not well served if the endodontic treatment is successful but the tooth fails. The long-term viability of endodontically treated teeth is no longer a ‘‘given’’ in the implant era. In consequence, some teeth that might have received endodontic treatment in the past are now extracted and replaced with implant-supported prostheses if they are marginally restorable or it makes more sense in the overall treatment plan. It is not possible to review in one article all the literature on the restoration of endodontically treated teeth. This article therefore focuses primarily on current concepts based on the literature from the past 10 years or so, and provides treatment guidelines based on that research. **PDF**

Schwartz, R., Robbins, JW. **Post placement and restoration of endodontically treated teeth: L literature review**. *JOE Vol 30, No.5 Mat 2004 289-301.*

The restoration of endodontically treated teeth is a topic that is extensively studied yet remains controversial from many perspectives. This article reviews the major pertinent literature on this topic with an emphasis on major decision-making elements in post-placement and restoration of endodontically- treated teeth. Recommendations are made for treatment planning, materials and clinical practices from restorative and endodontic perspectives. Conclusions: the trend in clinical practice is toward fiber posts, and the literature is generally, although not overwhelmingly, favorable toward them. Their performance in vitro approximates that of metal posts and most studies agree that there failure mode is more favorable than with metal posts. Clinical studies have been favorable to date. The use of fiber posts will probably continue to grow, assuming that future long-term clinical research studies report similar levels of success as seen in the relatively short-term studies already published. Further modifications of their physical and mechanical properties will probably also improve their clinical performance. **PDF.**

Sarkis-Onofre R, Skupien JA, Cenci MS, Moraes RR, Pereira-Cenci T. **The role of resin cement on bond strength of glass-fiber posts luted into root canals: a systematic review and meta-analysis of in vitro studies**. *Oper Dent. 2014 Jan-Feb;39(1):E31-44. doi: 10.2341/13-070-LIT. Epub 2013 Aug 12.*

Because there are several ways to cement glass-fiber posts (GFPs) into root canals, there is no consensus on the best strategy to achieve high bond strengths. A systematic review was conducted to determine if there is difference in bond strength to dentin between regular and self-adhesive resin cements and to verify the influence of several variables on the retention of GFPs. This report followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. In vitro studies that investigated the bond strength of GFPs luted with self-adhesive and regular resin cements were selected. Searches were carried out in the PubMed and Scopus databases. No publication year or language limit was used, and the last search was done in October 2012. A global comparison was performed between self-adhesive and regular resin cements. Two subgroup analyses were performed: 1) Self-adhesive × Regular resin cement + Etch-and-rinse adhesive and 2) Self-adhesive × Regular resin cement + Self-etch adhesive. The analyses were carried out using fixed-effect and random-effects models. The results showed heterogeneity in all comparisons, and higher bond strength to dentin was identified for self-adhesive cements. Although the articles included in this meta-analysis showed high heterogeneity and high risk of bias, the in vitro literature seems to suggest that use of self-adhesive resin cement could improve the retention of GFPs into root canals.

Soares, CJ, Valdivia, AD, Silva, GR, Santana, FR, Menezes, Mde S. **Longitudinal clinical evaluation of post systems: a literature review.** *Braz Dent J. 2012 Apr;23(2):135-740.*

In this survey, retrospective and prospective clinical studies dealing with cast-post-and core and fiber posts were reviewed regarding the rate of survival of restorations and the most prevalent failures. Electronic searches of the literature were performed in MEDLINE by crossing the key words: "Fiber post and clinical study", "Fiber post and clinical evaluation", "Cast post-and-core and clinical study", and "Root post and retrospective survival study". The cut-off dates were December 1990 through the end of December 2010. Review of literature showed that several interrelated biological, mechanical, and aesthetic factors are involved in the survival rate of restorative procedures in endodontically treated teeth, and post selection should fulfill and optimize these factors. Data based on long-term clinical studies are essential for the general practitioner when making clinical decisions. An adequate selection of teeth and post system must be made, and a minimal amount of existing tooth substance should be removed. A ferrule must be present for safe indication of the fiber posts. Fiber glass posts have demonstrated good survival in clinical studies, with similar performance to cast-post-and cores. Metallic posts have good clinical survival, but the associated failures are mostly irreversible, unlike what happens with the glass fiber posts.

Sorrentino, R, Di Mauro, MI, Ferrari, M, Leone, R, Zarone, F. **Complications of endodontically treated teeth restored with fiber posts and single crowns or fixed dental prostheses-a systematic review.** *Clin Oral Investig. 2016 Sep;20(7):1449-57. doi: 10.1007/s00784-016-1919-8. Epub 2016 Jul 26.*

Objective: The present systematic review aimed at assessing data from the literature on endodontic and prosthetic complications in endodontically treated teeth restored with fiber posts and single crowns (SCs) or fixed dental prostheses (FDPs). **Materials and methods:** Available randomized controlled clinical trials evaluating endodontic and prosthetic complications in the teeth treated with fiber posts and restored with different prosthetic restorations were reviewed. PubMed, Evidence-Based Dentistry, BMJ Clinical Evidence, Embase, DynaMed, and gray literature restricted to scientific literature were analyzed; also, manual researches were performed. English language and time filters (from 1990 to 2015) were used. **Results:** The database search produced 4230 records, many of which were duplicates. The manual research did not produce any other relevant article. After duplications were removed, all the selected databases produced 3670 records. Reading titles and abstracts, two independent reviewers excluded 3664 reports. The full-texts of the remaining six reports were read. Only four studies met the inclusion criteria and were included in this systematic review. **Conclusions:** The most frequently reported failures in the available studies were as follows: fiber post debonding, loss of retention of single crowns, and marginal gaps. Less frequently, chippings and fractures were recorded in SCs. No studies about complications related to FDPs were found. **Clinical relevance:** A correlation between the failure rates of fiber posts and the type of prosthetic restorations just like SCs and FDPs cannot be found to date. Further randomized controlled clinical studies are required to achieve evidence-based conclusions, particularly about the use of fiber posts with FDPs.

Ufuk Adali, U., Sterzenbach, G., Beuer, F., Naumann, M., **Biomechanical impact of crown-to-root ratio altering treatments of damaged incisors.** *J Dent Res. Vol 96 (Spec. Iss. A) Abstract #3549, 2017(www.dentalresearch.org)*

Objectives: This is the first ex-vivo study investigated the biomechanical impact of procedures altering the crown-to-root ratio R_{CR} in the aesthetic zone, aimed to restore severely damaged teeth. There is no evidence on the impact of apical surgery (AS), orthodontic extrusion (OE), and surgical crown lengthening (SCL) on load capability of upper central incisors. Procedures were compared to control and dental implant-born restoration (IBR) by 5-year dynamic (TCML) and subsequent linear loading (LL). **Methods**: Human maxillary central incisors were endodontically treated, decoronated and divided into 4 groups (n=48). Following specimen preparation was performed: (I) adhesive core-and-post build-up, (II) as (I) and 2mm apical root resection (AS), (III) before adhesive core-and-post build-up 2mm of the coronal part was removed (OE) (IV) as (I) (SCL), group (V) individual abutments on titanium implants (n=12; Æ4.1/l=12mm) (IBR). Only specimens of group IV were embedded 4mm instead of 2mm below the CEJ to simulate SCL. All specimens were restored with all-ceramic crowns, crown-to-root ratios calculated, exposed to TCML, and subsequent LL until failure occurs. Statistics: log-rank, Kruskal-Wallis, Mann-Whitney-U, ANOVA, and Chi-Square tests (p=0.05). **Results**: Fracture loads differed significantly (p=0.001) between groups. F_{max} median; min/max: (I) 275 (204/542), (II) 308 (243/443), (III) 270 (183/371), (IV) 206 (140/274), (V) 447 (370/539). Pair-wise comparison showed significant differences between teeth (group I-IV) and implants (group V) (p=0.001), and between I and IV (p=0.045), II and IV (p=0.001) and III and IV (p=0.033). R_{CR} differed significantly between group I compared to group II, III and IV (p=0.001). A R_{CR} below 1 (group IV) significantly decreased capability. **Conclusions**: SCL has a pronounced adverse effect on R_{CR} and subsequently on biomechanical behaviour, i.e. load capability of restored severely damaged teeth. OE appears to be a better option to ensure a 2mm ferrule to restore severely damaged teeth.

*Vichi, A., Schiavetti, R., Pacifici, E., Giovanetti, A. Goracci, C., Ferrari, M. **Masking of temperature-induced color changes in a Thermo-sensitive fiber post.** *Am J Dent 2012;25:123-128.*

Purposes: To evaluate (1) the efficiency of the color changing technology featured by the DT Light-Post Illusion Post (RTD, St Egreve, France) aimed at safely identifying the post in case of retreatment and,(2) the efficacy of a resin composite layer to mask the post if color shift occurs due to cold food and beverages. **Methods:** Five "master disks) of 3 mm of thickness were prepared by embedding in a resin composite for thermo-sensitive posts and one translucent post (control) cut in bars. Discs of resin composite in 0.5/1.0/1.5 mm thickness were prepared as well. Digital images were taken of the master discs with and without the

overlying of the resin composite discs, at 5° C and at 35° C temperature. By the use of Adobe Photoshop " layering function" and " multi-layer option", differences in color were calculated between the post-free and the post-containing areas. **Results:** The differences between the resin color and the post color were remarkably higher when the temperature was at 5° C, showing that the technology of color change of the post was effective. With resin disk overlaid, at 35° see none of the differences in color were above the threshold for clinical acceptability. At 5° C blue and black colored posts were visible when the overlaid resin thickness was 0.5 mm, while at 1.0 mm and 1.5 mm, none of the posts were visible. **Clinical significance**: Thermo-sensitive color pigment technology of DT Illusion was effective in selectively differentiating the post, by lowering the temperature, useful in case of endodontic re-treatment. Color changes due to cold food and beverage consumption were not visible if at least 1 mm of resin composite was layered over the post. **PDF**

*Barceleiro, M., Soares, LP, I. Poiate, IAVP, Portero, PP, Vasconcellos, AB, Teixeira, CA. **Influence of autoclave sterilization on flexural strength of fiberglass posts** . *J Dent Res. Vol 92 (Spec. Iss. A) Abstract #3130, 2013 (www.dentalresearch.org)*

Objectives: The sterilization of fiber-reinforced resin posts may be necessary if during adaptation tests, they are changed by other with different diameter. The sterilization in autoclave, however, may generate some kind of structural change that may prejudice their mechanical properties and clinical performance. The aim of this study was to evaluate the influence of sterilization method on the physical structure of reinforced fiberglass posts (FRC Postec - Ivoclar and Transluma - Bisco) or fiber quartz posts (DT Light Post - RTD/Bisco) after 1 or 2 cycles of sterilization. **Methods:** Eight posts of each brand, divided into 3 groups (FRC, TRL and DT), were subdivided into three subgroups, according to the number of sterilization cycles: a subgroup with no sterilization (control), one with one sterilization (Subgroup 2) and Subgroup 3 with 2 sterilization cycles. After sterilization procedures, the posts were submitted to three-pointing bending test (ASTM D2344). **Results:** The main values of maximum force required to fracture the pin in different groups were: DT1 (202 ± 8.39 N), DT2 (190.2 ± 10.02 N), DT3 (177.9 ± 14.75 N); FRC1 (152.6 ± 27.19 N); FRC2 (130.9 ± 25.99 N); FRC3 (128.1 ± 18.41 N); TRL1 (143.5 ± 6.15 N); TRL2 (144 ± 8.62 N); TRL3 (134 ± 6.51 N). The results treated by ANOVA and SNK ($p \leq 0.05$) showed significant differences within the groups DT (1 = 2> 3) and TRL (1 = 2> 3). **Conclusions:** It was concluded that the posts tested can be sterilized by an autoclave cycle with no loss in flexural strength. The FRC Postec Post can be sterilized by two cycles without mechanical damage.

*Iorizzo, G., Betazzoni, S., Ciocca,L, Baldissara, *P.,* **Effect of sterilization on fiber posts fracture Strength** . *J Dent Res. Vol 88 (Spec. Iss. B) Abstract #359, 2009 (www.dentalresearch.org)*

Objectives: Fiber post sterilization could be required for various reasons during clinical procedures. The purpose of this study was to evaluate the effect of autoclave sterilization on the fracture resistance of fiber posts made with different types of fiber. **Methods:** The specimens were subdivided in four groups of 10 posts each, as follows: 1) "S" glass Prosthetic OverPost #3 (Overfibers); 2) silica glass RelyX Fiber Post #2 (3M ESPE); 3) Glass-zirconia Fototech 1.8 (Isasan); 4) Quartz DT Light-Post Illusion #2 (RTD/Dentsply). In each group, five posts were subjected to two sterilization cycles at 135°C and 2 bar pressure, the other five were used as controls. The specimens were inserted in acrylic resin cylinders leaving an external portion 8mm in length, and loaded at 45° with an Instron machine until complete fracture occurred. A thin lead foil was inserted between the post head and the loading shaft to avoid stress concentration on the fiber composite. Fracture resistance and strain to failure were recorded and statistically analyzed (paired Student-t test, 1-way ANOVA, Bonferroni multiple comparison test, alpha=0.05). **Results:** Fracture resistance of RelyX (41.3±1.9 MPa) and Fototech (33.3±1.6 MPa)posts was significantly reduced by the treatment (24% and 24.8%, respectively; $P<0.004$). OverPosts and DT Light-Post Illusion resistance was not influenced by sterilization cycles ($P>0.9$); also, these posts showed a significantly higher strength (55.8±3.8 and 46.3±1.4 MPa, respectively) than the other types. Strain to failure of Fototech posts was significantly reduced by the treatment, increasing the stiffness of the glass-zirconia composite. **Conclusions:** fracture resistance of "S" glass fiber and quartz fiber posts are not affected by autoclave sterilization cycles.

*** Indicates that DT Light-Post is included **Indicates that Macro-Lock post is included**

Compiled and maintained by Norman Hicks consulting, Louisville, KY, USA

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