Three-year clinical comparison of survival of endodontically treated teeth restored with either full cast coverage or with direct composite restoration

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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.

Material and 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. (J Prosthet Dent 2002;88:297-301.)

CLINICAL IMPLICATIONS

In endodontically treated premolars with limited loss of tooth structure and restored with adhesive techniques and fiber posts, full-crown coverage did not result in better clinical results after 3 years of clinical service.

The pulpless tooth has usually lost substantial coronal and radicular tooth structure from pre-existing restorations, dental caries, and endodontic access preparation. This condition must be considered when a complete crown is planned. Tooth reduction for an artificial crown is considerable,[1] particularly when teeth are prepared for metal-ceramic crowns. For aesthetic reasons, this treatment is the most common system for crown coverage of premolars and anterior teeth.[2]

According to most clinicians, tooth preparation for a metal-ceramic crown normally requires an occlusal reduction of 2 mm,[3] an interproximal and labial reduction of 1.5 mm,[4] and a lingual reduction of 1.2 mm.[3] Therefore, for the vast majority of endodontically treated premolars and anterior teeth with such a reduction, the loss

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of tooth structure is so substantial that a post should be used to provide core retention. Little documentation exists regarding the description and outcome of endodontically treated teeth restored with posts that have been covered with metal-ceramic crowns or left uncovered. This finding is surprising given the clinical prevalence of this procedure. The need for a full-coverage crown to prevent root fracture in endodontically treated posterior teeth has been supported by in vitro studies[5,6] and by retrospective clinical studies.[7,8] Sorensen and Martinoff[8] reviewed 1273 endodontically treated teeth that had been restored from 1 to 25 years. Statistical analysis showed that coronal coverage did not significantly improve the rate of clinical success for anterior teeth, whereas it improved success for premolars and molars. More recent retrospective clinical studies evaluated the performances of post-core restorations.[9-11] In a 4- to 5-year retrospective study,[9] a significantly higher success rate was recorded for parallel-sided serrated posts compared with custom-cast posts. No failure was observed in fiber-post restorations after a mean observation time of 32 months,[10] whereas after a longer follow-up period (1 to 6 years) similar restorations showed a 3.2% failure rate.[11]

Preservation of sound tooth structure is regarded as the most important aspect in increasing survival rate of endodontically treated teeth.[12-14] In retrospective clinical reports,[15,16] premolars were found to be the most frequently fractured teeth. Endodontically treated teeth with MO/DO or an MOD cavity restored only with composite without cuspal overlay were found to survive for years.[17] However, no prospective clinical study has compared the failure rate of endodontically treated premolars restored with fiber posts and composite with that of teeth restored by the same technique but covered with metal-ceramic crowns.

The aim of this study was to evaluate the clinical success rate of endodontically treated premolars restored with fiber posts and direct composite restorative materials and to compare them with similar treatments restoring the tooth with a full-coverage metal-ceramic crown. The research hypothesis was that, in teeth with limited loss of tooth structure, endodontic treatment and core buildup with adhesive techniques, fiber posts, and composite would give equivalent failure rates and failure modes as teeth restored in a similar manner with full crown coverage.

MATERIAL AND METHODS

Each subject provided informed consent to participate in the study, which was approved by the appropriate committee of the University of Siena. Subjects had to have one maxillary or mandibular premolar for which endodontic treatment and crown build up was indicated. Only teeth without previous endodontic treatment with Class II carious lesions and preserved cusp structure were included. The selected teeth needed to be in occlusal function after restoration and were not used as abutments for fixed or removable partial dentures. Teeth selected did not display loss of periodontal attachment less than 40%. For the evaluation of the presence of gingival inflammation, the gingival index score was used.[18] Subjects were excluded from the study if the gingiva bled spontaneously (gingival index score 3). All subjects received oral hygiene instruction from a dental hygienist. Subjects had to be healthy and willing to return at regular intervals for evaluation.

A total of 117 subjects were included in the trial (54 men, 63 women). The age of subjects ranged from 35 to 55 years, with a mean of 48 years. Their education levels indicated that 61% had a high school or university degree. Teeth included in the study were 24 maxillary first premolars, 57 maxillary second premolars, 3 first and 33 mandibular second premolars. Sixty teeth were included in the first group and 57 in the second. Differences regarding age and caries prevalence between gender were subjected to statistical analysis by use of 1-way analysis of variance.

The selected subjects were randomly assigned to 1 of the following 2 experimental groups by tossing a coin. Teeth in Group 1 were endodontically treated and restored with adhesive techniques and composite, whereas teeth in Group 2 were endodontically treated, restored with adhesive techniques and composite, and covered with full-coverage metal-ceramic crowns. The composite crown build-up was performed with the same technique for the 2 experimental groups. All restorations were performed by a single operator. Operative procedures were performed following a treatment protocol based on the following clinical procedures.

Root canal treatment

Teeth were isolated with rubber dam for root canal therapy and crown buildup. Root canal treatment was performed under local anesthesia with a chemo-mechanical technique.[19] The root canal filling was performed with laterally condensed gutta-percha and endodontic sealer (AH Plus; Dentsply De Trey, Konstanz, Germany). All teeth were prepared and the roots filled in the same appointment. All teeth received a temporary restoration with a zinc oxide eugenol-free composite material (Fermit; Ivoclar-Vivadent, Schaan, Liechtenstein).

Composite crown buildup

One week after root canal filling, gutta-percha was removed to a depth of 7 mm or, whenever possible, to a depth equal to the length of the root canal by use of Largo drills (Maillefer, Baillagues, Switzerland). The drill working length was controlled with silicone stops.[19]

The walls of the root canals were enlarged with low-speed burs provided by the manufacturer for the preparation of a size 1 carbon fiber post (Composipost; RTD, St Egreve, France). Post diameter was 1.4 mm in the coronal part and 1.2 mm in the apical 2 mm. The post space depth preparation was the same as that of the gutta-percha removal. This depth was obtained by use of a line painted on the shank of the burs at a distance of 9 mm from the bur tip as a reference point. The root canal walls of teeth of both groups were etched with 32% phosphoric acid (All Etch; Bisco, Itasca, Ill.) for 30 seconds, washed with water spray, and gently air-dried. Primers A and B (All Bond 2; Bisco) were mixed and applied in the canals. Dentin bonding material (All Bond 2 Pre-Bond Resin; Bisco) was applied in the canal. A layer of dentin bonding primer was applied on the carbon fiber posts, then equal volumes of base and catalyst of luting composite (C&B; Bisco) were mixed for 10 seconds according to manufacturer's instructions. The cement was applied on the post surface, the post was inserted into the canal, and the cement was allowed to set for 7 minutes. A number 1001 Tofflemire metal matrix band (Hawe Neos Dental, Bioggio, Switzerland) was positioned on the tooth, and wooden wedges were used to improve interproximal adaptation. Composite (Z100; 3M, St. Paul, Minn.) was placed incrementally in 2-mm layers. Each layer was exposed for 40 seconds with a visible light-polymerizing unit (Visilux 2; 3M) and no composite cusp coverage was performed.

Crown preparation (Group 2)

For the metal-ceramic crown group, crown preparation was performed 1 week after crown buildup. Crown preparation procedures were standardized as much as possible as described by Walton.[2,20] A conventional preparation was performed using a diamond bur (ISO n 836; Komet, Lemgo, Germany) with a convergence of approximately 2.0 degrees with the aim of obtaining a 6-degree convergence between walls. All teeth were prepared with a long chamfer, and all margins were placed at the gingival level. Occlusal reduction and crown margins were prepared using a diamond bur (ISO n 836; Komet), and a 1-mm minimum of coronal dentine was left above the chamfer.

Impressions were made with a polyether impression material (Permadyne; Espe, Seefeld, Germany) by use of a custom tray. All impressions were placed in a standard disinfectant solution (Sporicidin Plus DS; IMS, Rome, Italy) for 10 minutes. After disinfection, the impressions were rinsed under running water for 15 seconds. Casts were formed from the impressions 2 hours after impressions were made. All master dies were produced with quick-set ISO type 1 plaster (Snow White No. 2; Kerr Italia, Naples, Italy). One commercial laboratory fabricated all crowns by use of a gold platinum-palladium alloy (Jelenko O; JF Jelenko Co, Armonk, N.Y.).

After the impression procedure, a temporary resin crown was immediately adapted and cemented on prepared tooth using a zinc oxide eugenol based temporary cement (Temp Bond; Kerr Italia). The casting try-in was performed 1 week after the impression was made. Because 15 castings fit poorly to the prepared tooth, new impressions were made and new castings were prepared. After the casting try-in, the porcelain was applied. The crowns were cemented 1 week after the casting try-in by use of a zinc oxide eugenol based temporary cement (Temp Bond; Kerr Italia). Two weeks after temporary cementation the crowns were removed; definitive cementation was performed with zinc phosphate cement (SS White cement; SS White, Lakewood, N.J.).

Clinical criteria for success and failure

Causes of failure were categorized as root fracture, post fracture, post decementation, clinical and/or radiographic evidence of a marginal gap between tooth and restoration, or clinical evidence of secondary caries contiguous with the margins of the restoration. Clinical evaluation included visual inspection conducted with loops with fiberoptic coaxial illumination (Zeon Illuminator; Orascoptic Research, Madison, Wis.) at original magnification × 3, examination of the continuity of the margins of the restoration with the tooth structure by use of an explorer (EXS6; Hu Friedy, Leiman, Germany) and periodontal probing performed with a periodontal probe (Perio-Probe; ASA Dental 1-2, Lucca, Italy). Color slides (1:1 mirror shots) of the restorations were taken with standard film (Kodak Elitechrome 100; Eastman Kodak Company, Rochester, N.Y.). In 2 recent clinical studies on Class II restorations,[21,22] the presence of secondary caries was evaluated only by clinical examination. In this study, as in other clinical reports on teeth with similar loss of crown structure,[23,24] a radiographic observation was included. Periapical radiographic examination was performed by use of a paralleling technique at 65 kV and 8 mA. A radiographic extension cone (Orix AET; Ardet, Buccinasco, Italy) was used in combination with a paralleling device (Rinn XCP; Rinn Corp, Elgin, Ill). Ultra-Speed periapical 31 × 41 mm dental films (DF-57; Kodak) were used. Radiographs were observed projected onto a screen of 60 × 90 cm. The clinical, radiographic, and photographic examinations were performed immediately before restoration, immediately after restoration, and at 1-, 2-, and 3-year recall. Failure caused by root fracture was noted when, after extraction, a fracture line was evident at inspection. Post fracture was defined as a separation of 2 post parts at inspection. Post decementation was defined as a separation of the post-core (crown) restoration from tooth structure. Radiographic evidence of a mar-

Table I. Failure rate and failure modes at the 1-, 2- and 3-year recalls

Year		Composite only (Group 1)	Composite and crown (Group 2)	Δ	95% CI
1	Sample size	60	57		
	Recall	55	57		
	Failure	0	0		
2	Recall	48	57	−0.99	−17.5 to 12.6
	Failure	3	3		
	(Decementation of post)	1	2		
	(Marginal gap formations)	2	1		
3	Recall	50	54	−2.0	−14.9 to 8.89
	Failure	1	0		
	(Marginal gap formations)	1			

Δ, Difference in percentage failures between Group 1 and Group 2; 95% CI, exact 95% confidence about Δ.

ginal gap formation between tooth and restoration was defined as a visible opening between tooth structure and restoration observed by both examiners. Failure caused by clinical evidence of a marginal gap formation between tooth and restoration was reported when the explorer caught. Clinical evidence of secondary caries contiguous with the restoration margin was reported when, after the removal of the restoration because of the presence of a marginal gap formation, the presence of caries close to the restoration margin of the restoration was observed.

Evaluation of success or failure was performed by 2 examiners other than the operator. Interexaminer and intraexaminer agreement exceeded 90% at regular calibration exercises. Missing data (lost to follow-up) were censored at the last date when information was available. Teeth lost as a result of trauma, endodontic, or periodontal problems were considered as missing data. The 2 groups were compared by calculating 95% confidence intervals about the difference between the groups. If this confidence interval included the value of 0, then there was no difference between the 2 groups.[25] Data were analyzed by use of a computer program (StatXact-3; CYTEL Software Corp, Cambridge, Mass.). The exact 95% confidence interval for the difference between the 2 appropriate failure proportions was calculated as described by Berger and Boos.[26] For this specific application, it is important to use exact inference because of the small number of failures, because conventional asymptotic inference will lead to incorrect results.

RESULTS

Results for each year are summarized in Table I. No teeth were lost as a result of trauma or endodontic or periodontal problems. At the 1-year recall, no failure was reported. The only failure modes observed at 2 and 3 years were post decementations and the presence of marginal gap formations. There was no difference (95% confidence interval, −17.5 to 12.6) in failure frequencies between the 2 groups. Because failure only occurred in years 2 and 3, the data were pooled in Table II. The observed failures were post decementation (1 from Group 1 and 2 from Group 2) and marginal gaps as revealed by radiographs (3 from Group 1 and 1 from Group 2). There was no difference between the number of post decementations or marginal gaps between the 2 groups (95% confidence intervals, −9.7 to 16.2 and −17.8 to 9.27). The Newman-Keuls multiple comparison test (at the 0.05 significance level) was used to evaluate statistical differences between the means of the results obtained. No significant difference was found.

DISCUSSION

The results of the study upheld the research hypothesis that, in teeth with limited loss of tooth structure, endodontic treatment and building up by use of adhesive techniques, fiber posts, and composite would give equivalent failure rates and failure modes as teeth restored in the same manner but with full crown coverage. If the study could have been designed to include matched pairs of teeth, this arrangement would have been desirable to reduce bias. Unfortunately, it is practically impossible to collect a minimum number of 50 subjects with 2 premolars with Class II carious lesions who also need endodontic treatment. Therefore a single tooth for each patient was included in the study. Restoration with adhesive techniques was chosen because it allowed preservation of the maximum amount of sound tooth structure. Furthermore, direct composite restoration of premolars can be considered to be more predictable than that of molars.[22] This concept was anticipated because of the lower polymerization contraction stress caused by the smaller amount of composite needed for the restoration. Also, the interproximal margins of premolars are more accessible for inspection and finishing procedures. The results of this study cannot be compared with other studies on post-crown[9-11] or composite[17] restorations of endodontically treated teeth because they were all retrospective.

Table II. Combined data for years 2 and 3

	Composite only (Group 1)	Composite + crown (Group 2)	Δ	95% CI
Recall	53	54		
Failure	4	3	−2.00	−17.3 to 12.8
Decementation of post	1	2	1.8	−9.7 to 16.2
Marginal gaps	3	1	−3.8	−17.8 to 9.27

Δ, Difference in percentage failures between Groups 1 and 2; 95% CI, exact 95% confidence about Δ.

The 3-year results revealed the absence of the most serious failure types, such as root and post fractures; all the observed failures were post decementations and marginal gaps revealed by radiographs. The failed restorations were replaced with new restorations of the same type and the teeth were maintained in clinical service. The 2 failure types observed might be correlated because it was shown that fiber posts become flexible[27] and therefore lead to post decementation when left in contact with water. Decementation may occur when microleakage from a marginal gap formation exists between the tooth and restoration.

Wear rate is a failure mode that was not included in this study. This parameter might affect the long-term clinical performance of composite crown buildups without crown coverage. The wear rate of teeth restored with composite alone therefore needs to be evaluated frequently and compared to the cast situation.

This study is planned to continue until year 6. Therefore if the relatively low failure rate and the absence of the most serious complications can be confirmed in 5-year recalls, restoration of selected endodontically treated teeth with fiber posts and composite without any crown coverage might be considered an economic and tooth-saving alternative to the more expensive and less conservative crown coverage. Further studies are also needed to compare the results obtained by use of composite restorations supported by fiber posts with those performed with metal posts.

CONCLUSIONS

Within the limitations of the study, ceramo-metal crown coverage did not enhance the clinical performance of endodontically treated and restored teeth when compared with placement of a direct composite restoration over a 3-year time span.

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