Correspondence between fiber post and drill dimensions for post canal preparation

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Abstract: Purpose: To compare fiber posts of several calibers and trademarks to their corresponding root canal preparation drills. **Methods:** Three widely used endodontic post brands and their drills were evaluated: Exacto, ParaPost Taper Lux, and Macro-Lock Illusion X-RO. Fiber posts and drills were microphotographed with a scanning electron microscope and images were analyzed using ImageJ image processing software. Fiber post diameter on apical extreme (Pd0), fiber post diameter at 5 mm from the apical extreme (Pd5), drill diameter on apical extreme (Dd0) and drill diameter at 5 mm from the apical extreme (Dd5) were analyzed. The data were statistically analyzed using student t-test. **Results:** Exacto posts 0.5 showed larger dimensions than their corresponding drills ($P< 0.05$) at Pd0. Macro-Lock posts showed no significant differences vs. their drills at Pd0 in any of the studied groups. ParaPost drills 4.5, 5 and 5.5 were statistically significantly larger than their posts at Dd0 ($P< 0.05$). Exacto posts 0.5 and 1 showed larger dimensions than their drills measured at Pd5 ($P< 0.05$). Exacto posts number 2 showed smaller calibers than their corresponding drills at Pd5 ($P< 0.05$). Macro-Lock drills number 4 and ParaPost drills number 5 were larger than their posts at Dd5 ($P< 0.05$). (*Am J Dent* 2017;30:295-298).

Clinical significance: Poor spatial correspondence between post and drill dimensions can adversely affect the film thickness of the resin cement, diminishing bond strength due to polymerization shrinkage. The lack of correspondence in size between posts and drills may lead to the formation of empty chambers between the post and endodontic obturation with excessive luting cement thickness, thus inducing critical C-Factor stresses.

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Introduction

Fiber posts are used as connectors between root and coronal restorations after endodontic treatments in cases where the coronal remnant tissues cannot provide enough support or retention.[1-4] To be able to resist forces that tend to dislodge them, posts must properly adapt to the root canal preparation walls.[5-7] An adequate adaptation of the post towards root canal preparation walls ensures mechanical lock, enhancing its retention.[8] Mechanical lock is related to post friction against preparation walls. A proper adaptation of the post to the root canal preparation leads to higher retention values and ensures a more even transmission of forces from the post to the root, thus preventing stress concentration points and allowing both the root and the endodontic post to receive less mechanical demands.[8] In addition, an adequate adaptation between post and root canal preparation diminishes the thickness of the luting material, protecting the cementation process.[1,9-12]

Post preparation represents a very high C-Factor cavity. Whenever the thickness of the resin cement increases due to an inappropriate fit of the post, polymerization shrinkage stresses also increase, making the resin cement prone to debonding most frequently from the dentin surface.[13] Moreover, the size discrepancy between post drills and fiber post diameter can generate a gap formation between the cement and the dentin interface.[9,10,13]

To obtain a precise fit between the post and the root canal preparation, the existence of a precise dimensional relationship between the posts and the drills is essential.[14]

The market offers cylindrical and cylindrical-conical posts. Cylindrical posts induce higher friction forces providing better retention of the post, but can generate an excessive thinning of the dentin walls in the apical extreme of the root, causing a danger zone in the tip of the preparation.[15] However, dental roots have a conical shape, so cylindrical-conical posts fit better. They have a cylindrical shape at the cervical third of the root, and conical shape in the tip, fitting in the part of the root with less dentin thickness. The apical portion of the post should offer the highest accuracy with the canal preparation walls in the root canal as this is the part of the post that corresponds to the more circular section of the root canal. It is in the apical zone where posts obtain mechanical retention, which is the main condition to avoid failure by dislocation.[16-20]

Anatomizing techniques of fiber posts such as addition of composite resin or fiber layers, are often performed over the cervical or middle part of the post because of the loss of circularity in cervical areas. However, these techniques are rarely carried out in the apical part of the post.[9] For all these reasons, it is extremely important to establish a proper dimensional correspondence between drills and fiber posts in the apical third of the post preparation.

This study compared fiber posts of different trademarks and sizes to their corresponding root canal preparation drills.

Materials and Methods

Three widely used endodontic post trademarks and their corresponding drills were selected and analyzed in this research study. Five posts and five drills of each trademark and size were analyzed, all of them corresponding to different commercial kits. Experimental groups were divided as follows:

Group 1: Glass fiber post Exacto,[a] sizes 0.5, 1, 2, 3 (n=20).

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Table 1. Comparisons between fiber posts and their corresponding drills measured at apical extreme (Pd0 vs. Dd0).

Post and drill dimensions at d0 - Post and drill trademarks and sizes								
	N	**Exacto 0.5**	**N**	**Exacto 1**	**N**	**Exacto 2**	**N**	**Exacto 3**
Post	n= 5	586.8 ± 40.9***	n= 5	700.4 ± 40.8 NS	n=5	951.4 ± 58.0 NS	n= 5	1118.6 ± 46.7 NS
Drill	n= 5	467 ± 3.5***	n= 5	688.8 ± 5.0 NS	n= 5	879.4 ± 12.0 NS	n= 5	1065.6 ± 8.7 NS
		Macro-Lock 1		**Macro-Lock 2**		**Macro-Lock 3**		**Macro-Lock 4**
Post	n= 5	801.2 ± 6.9 NS	n= 5	797.8 ± 7.4 NS	n= 5	1004.2 ± 4.6 NS	n= 5	998.4 ± 13.1 NS
Drill	n= 5	803.2 ± 6.4 NS	n= 5	806.6 ± 2.4 NS	n= 5	997.6 ± 5.94 NS	n= 5	1002 ± 2.7 NS
		ParaPost 4.5		**ParaPost 5**		**ParaPost 5.5**		**ParaPost 6**
Post	n= 5	778.8 ± 6.5 ***	n= 5	963.6 ± 9.0 ***	n= 5	956.8 ± 8.1 ***	n= 5	1067.4 ± 14.0 NS
Drill	n= 5	852.4 ± 3.3 ***	n= 5	1022.4 ± 5.1 ***	n= 5	1020.2 ± 6.4 ***	n= 5	1080.8 ± 6.1 NS

*** Student t-test (P< 0.01); NS = not significant.

Table 2. Comparisons between fiber posts and their corresponding drills measured at 5 mm from the tip (Pd5 vs. Dd5).

Post and drill dimensions at d5 - Post and drill trademarks and sizes								
	N	**Exacto 0.5**	**N**	**Exacto 1**	**N**	**Exacto 2**	**N**	**Exacto 3**
Post	n= 5	1097.4 ± 26.9***	n= 5	1163.6 ± 10.1 ***	n= 5	1429.6 ± 42.6 **	n= 5	1853 ± 43.9 NS
Drill	n= 5	975.6 ± 7.3***	n= 5	1145 ± 4.7 ***	n= 5	1490.6 ± 4.2 **	n= 5	1889.8 ± 4.1 NS
		Macro-Lock 1		**Macro-Lock 2**		**Macro-Lock 3**		**Macro-Lock 4**
Post	n= 5	1282.2 ± 6.34 NS	n= 5	1270.8 ± 9.7 NS	n= 5	1460.4 ± 21.2 NS	n= 5	1507 ± 5.5 ***
Drill	n= 5	1281.4 ± 5.9 NS	n= 5	1264.4 ± 6.3 NS	n= 5	1462.8 ± 8.3 NS	n= 5	1523.4 ± 5.9 ***
		ParaPost 4.5		**ParaPost 5**		**ParaPost 5.5**		**ParaPost 6**
Post	n= 5	1118.6 ± 25.1 NS	n= 5	1227.4 ± 13.7 ***	n= 5	1468.8 ± 8.7 NS	n= 5	1498.6 ± 67.7 NS
Drill	n= 5	1111.6 ± 44.5 NS	n= 5	1306.6 ± 8.2 ***	n= 5	1484.8 ± 6.4 NS	n= 5	1514.4 ± 7.9 NS

*** Student t-test (P< 0.01); NS = not significant..
** Student t-test (P< 0.05);

Group 2: Quartz fiber post Parapost Taper Lux,[b] sizes: 4.5, 5, 5.5, 6 (n=20).

Group 3: Quartz fiber post Macro-Lock Illusion X-RO,[c] sizes 1, 2, 3, 4 (n=20).

Group 4: drills for Exacto, sizes 0.5, 1, 2, 3 (n=20).

Group 5: drills Parapost Taper Lux, sizes: 4.5, 5, 5.5, 6 (n=20).

Group 6: drills Macro-Lock Illusion X-RO, sizes 1, 2, 3, 4 (n=20).

Fiber posts were gold-coated for SEM evaluation. Drills and fiber posts were micro photographed under a scanning electron microscope (Supra 55VP[d]) at ×55 magnification. Images were analyzed employing the ImageJ[e] analysis software (version 1.48). The parameters analyzed were: fiber post diameter on apical extreme (Pd0), fiber post diameter at 5 mm from the apical extreme (Pd5), drill diameter on apical extreme (Dd0), and drill diameter at 5 mm from the apical extreme (Dd5). All measurements were performed by the same operator. Comparisons between fiber posts and their corresponding drills were performed using student t-test. The data were reported as mean ± SD. Statistical significance was set at P< 0.05, using the Primer of Biostatistics Statistical Analysis Program[f] (version 3.02).

Results

Differences between post diameters and their corresponding drills at apical extreme (d0) and at 5 mm from tip (d5) are expressed in Tables 1 and 2.

Differences between posts and their drill dimensions at d0 - Exacto posts 0.5 showed larger dimensions than their corresponding drills (P< 0.05) at Pd0 (Table 1). Macro-Lock posts showed no significant differences vs. their drills at Pd0 in any of the studied groups. ParaPost drills 4.5, 5 and 5.5 were statistically significantly larger than their posts at Dd0 (P< 0.05).

Differences found between posts and their drills at d5 - Exacto posts 0.5 and 1 showed larger dimensions than their drills measured at PD5 (P< 0.05) (Table 2). Exacto posts number 2 showed smaller caliber than their corresponding drills at Pd5 (P< 0.05). Macro-Lock drills number 4 were larger than their posts (P< 0.05). ParaPost drills number 5 were larger than their posts (P< 0.05).

Different surface conditions were found on the studied posts under the SEM observation (Fig. 1). A smooth surface without fibers was observed on ParaPost Taper Lux and Macro-Lock. Over several of the Exacto posts a lack of integration between the fibers and resin matrix was observed. A superficial disintegration aspect with glass fibers exposed was evident. In order to compare the lateral morphology of drills and posts, some images have been overlapped (Fig. 2). This overlap shows a slight difference among the sizes of the ParaPost Taper Lux drills, which would explain the differences found between the sizes of their corresponding posts.

Discussion

An accurate spatial relationship between posts and drills will offer better chances for a proper adaptation of the posts.[5,8-10,13,14] In the present study, drills with larger dimensions than the posts and posts with larger dimensions than their corresponding drills were observed.

It is important to consider that when drills are larger than posts, posts can suffer a reduction in their retention.[8]

In situations where the drill has a smaller diameter than the post, it is evident that the post will have difficulties to reach the bottom of the preparation. An empty space can be generated between the extreme end of the post and the limit of the root canal obturation. That space would be filled by the cementation

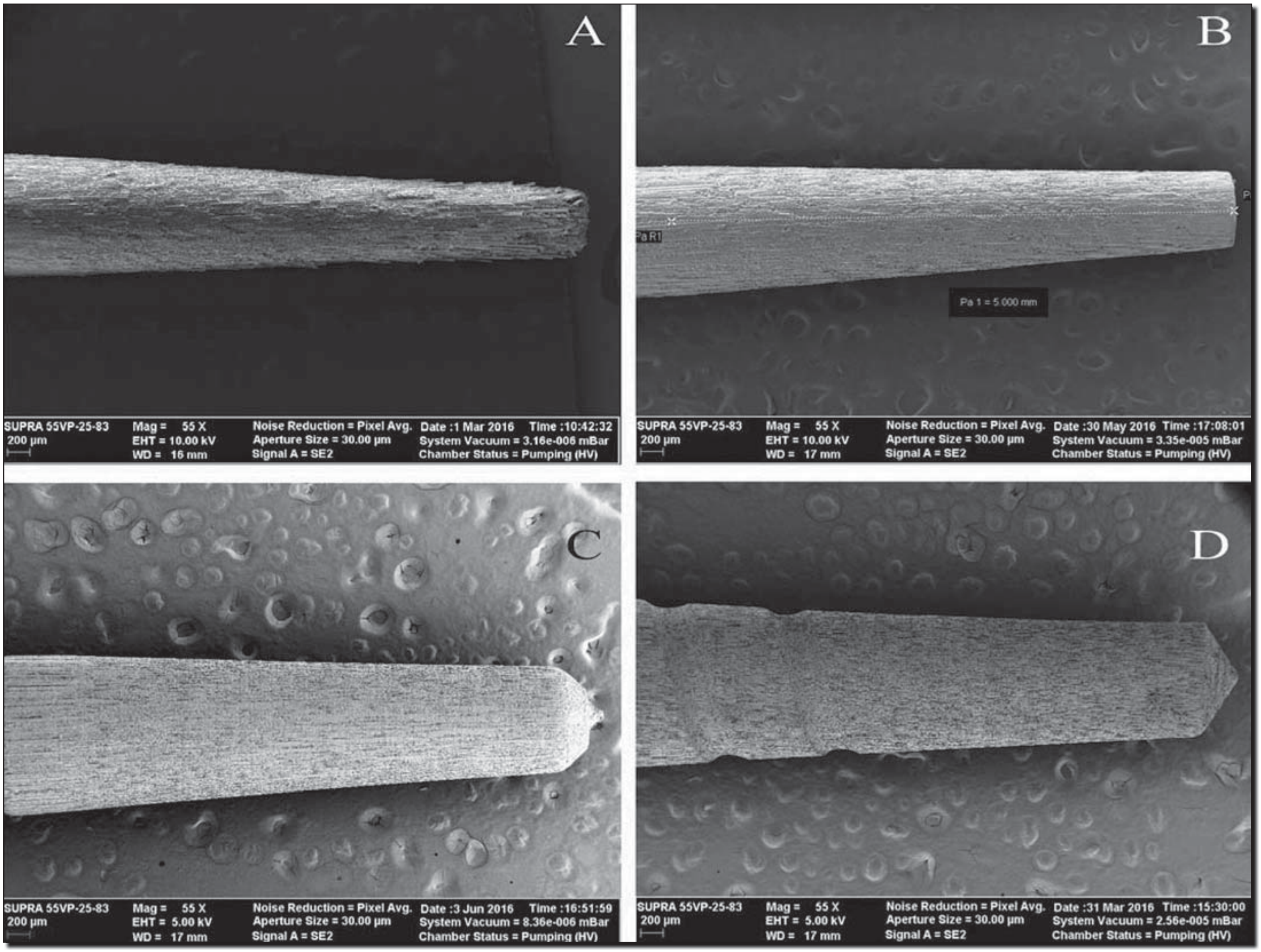

Fig. 1. Fiber posts SEM microphotographs. **A**. Fiber exposure in Exacto 0.5. **B**. Exacto 1 showed a more even surface. **C.** ParaPost Taper Lux 5.5. **D**. RTD Macro-Lock X-RO Illusion 4.

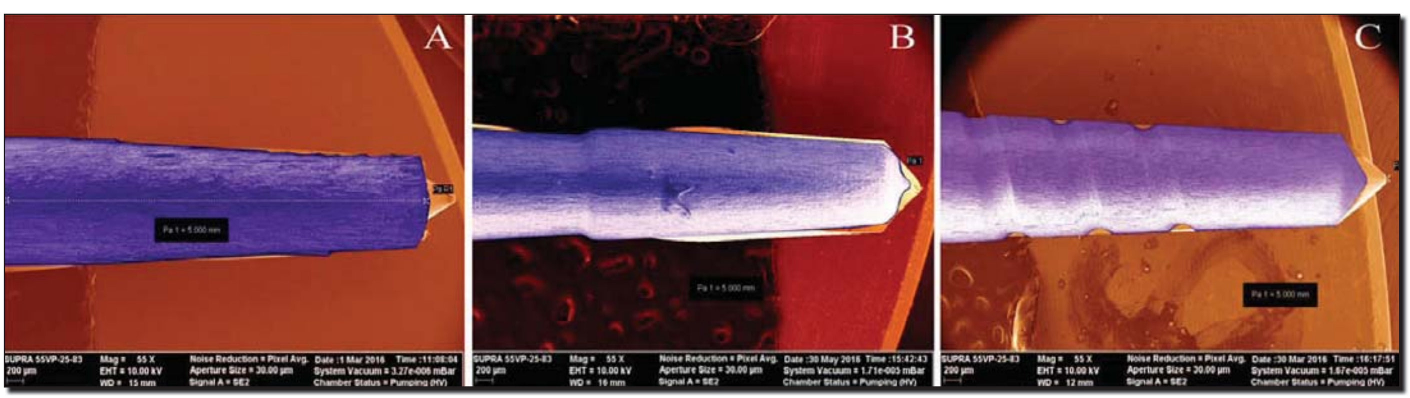

Fig. 2. SEM microphotographs of fiber posts and their corresponding drills overlapping. Their shapes and dimensions were compared. **A.** Exacto 2. **B.** ParaPost Taper Lux 5. **C.** Macro-Lock X-RO Illusion 2. In this image microphotographs were used in their original sizes. Images were cut, painted and overlapped using AdobePhotoshop CS 8.0.1 software.

material of the post but in other cases the space would be left unfilled with cement with possible growth and development of bacteria over time.[17]

SEM observations showed exposure of fibers in some fiber posts. This phenomenon occurs especially in the apical end of the post and it is the probable cause of the dimensional inaccuracies among the posts and drills. Some authors consider the interfacial bond between fibers and resin matrix of paramount importance for the mechanical behavior of the fiber post.[12,21-24]

In conclusion, according to the findings in this study, some brands of posts present differences in the sizes between certain posts and their corresponding drills. The dimensional differences between fiber posts and their corresponding drills and the structural defects in fiber posts found in this study, can be taken into account by the industry to improve quality standards in the manufacture of posts.

a. Angelus Industria de Produtos Odontológicos SA, Londrina, Brazil.
b. Coltène/Whaledent, Altstätten, Switzerland.
c. RTD Dental, Grenoble, France.
d. Carl Zeiss AG, Oberkochen, Germany.
e. National Institutes of Health, Bethesda, MD, USA.
f. McGraw Hill, Inc. Atlanta, GA, USA.

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