

COMPARISON OF THE FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH RESTORED WITH PREFABRICATED POSTS AND COMPOSITE RESIN CORES WITH DIFFERENT POST LENGTHS

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ABSTRACT

Objective: This study evaluated the fracture strengths of endodontically treated teeth restored with prefabricated posts with different post lengths. Material and methods. Thirty freshly extracted canines were endodontically treated. They were randomly divided into groups of 10 teeth and prepared according to 3 experimental protocols, as follows; Group 1/3 PP: teeth restored with prefabricated post and composite resin core (Z250) with post length of 5.0mm; Group 1/2 PP and Group 2/3 PP: teeth restored with prefabricated post and composite resin core (Z250) with different combinations of post length of 7.5mm and 10mm, respectively. All teeth were restored with full metal crowns. The fracture resistance (N) was measured in a universal testing machine (crosshead speed 0.5mm/min) at 45 degrees to the tooth long axis until failure. Data were analyzed by one-way analysis of variance ($\alpha=.05$). Results. The one-way analysis of variance demonstrated no significant difference among the different post lengths ($P>.05$) (Groups 1/3 PP = 405.4 N, 1/2 PP = 395.6 N, 2/3 PP = 393.8 N). Failures occurred mainly due to core fracture. Conclusion. The results of this study showed that an increased post length in teeth restored with prefabricated posts did not significantly increase the fracture resistance of endodontically treated teeth.

Uniterms: Post and core technique; Composite resins; Fracture stress.

INTRODUCTION

The restoration of non-vital teeth is an important aspect of dental practice that involves a range of treatment options of variable complexity. Numerous techniques using post and core restorations have been advocated with criteria for success depending on variations in length⁴ diameter^{8,26}, shape and surface configuration^{22,24}, and materials and techniques used for their construction^{8,20}.

The likelihood of survival of a pulpless tooth is directly related to the quantity and quality of the remaining dental tissue²⁷. A post is usually placed in an attempt to strengthen the tooth^{3,9,13}. However, "in vitro" and "in vivo" studies have demonstrated that posts do not reinforce endodontically treated teeth^{14,20,23,30}. Posts are required to supporting a core foundation when there is insufficient remaining structure of clinical crown^{14,20,23,30}.

Although cast post and core restorations are the choice for endodontically treated teeth when the coronal tooth

structure is missing, prefabricated post systems are popular because they save time and can provide satisfactory results^{16,25,28}. Despite the efforts to reinforce endodontically treated teeth with internal posts and cores, tooth fractures continue to occur¹³. Some authors^{2,12} demonstrated that roots restored with cast posts exhibited significantly higher internal stresses than prefabricated posts. With recent improvements in the bonding of composite resins to dentin, true internal retention became available^{1,5,6,14,19-21}.

The length of a post relative to root length is an unresolved problem in post design^{10,11}. Laboratory studies have shown that increasing the length of the post results in a more favorable stress distribution along the root^{15,19,24} and an increased post length improves the resistance of the restored tooth to fracture²⁹. Furthermore, Sorensen and Martinoff²³ demonstrated that an increased survival rate has been correlated with increasing post length. However, a study conducted by Burns, et al.⁷ showed a minimal difference in stress distribution between varying post lengths. Similarly,

Isidor, et al.¹⁷ observed that an increase in post length does not necessarily increase the fracture resistance of the tooth.

It is important to notice that it may not always be possible to use a long post, especially when the remaining root is short or curved. Kvist, et al.¹⁸ and Mattison, et al.²¹ suggested that it is important to preserve 3 to 5mm of apical gutta-percha to maintain the apical seal.

The purpose of this study was to evaluate the fracture resistance of endodontically treated teeth restored with prefabricated posts with different post lengths. The null hypothesis of the present study was that the different post lengths would not influence the fracture strength of endodontically treated teeth.

MATERIAL AND METHODS

Thirty recently extracted maxillary canines with similar root sizes (between 15mm and 16mm) measured with a millimeter ruler from the apex to the cemento-enamel junction (CEJ) were selected from 47 maxillary canines extracted for periodontal reasons. After the roots were scaled with periodontal curettes and water, they were sectioned with double-faced diamond discs (KG Sorensen, Barueri, SP, Brazil) to a standardized length of 15mm. The teeth were stored in distilled water at 37°C. The inclusion criteria for tooth selection were teeth without root surface carious lesions or fissures and not previously subjected to endodontic therapy. Each canal was prepared at 1mm of the radiographic apex with a standard master apical file #20 (Dentsply Maillefer, Ballaigues, Switzerland). Master apical files (Dentsply Maillefer, Ballaigues, Switzerland) 3 sizes larger (#25, #30, and #35) than the initial instrument were used. The root canal for each tooth was instrumented with a conventional step-back technique to an International Standardization Organization (ISO) file #35 (Dentsply Maillefer, Ballaigues, Switzerland) at the apical constriction. The canals were irrigated with 2.5% sodium hypochlorite solution (Asfer Industrial Química, São Paulo, SP, Brazil) throughout the preparation and dried with paper points (Tamari, Tamariman Industrial LTDA, Macaçaruru, AM, Brazil). Each canal was obturated by lateral condensation using gutta-percha cones (Tamari, Tamariman Industrial LTDA, Macaçaruru, AM, Brazil) and an ISO 35 primary gutta-percha master cone (Tamari, Tamariman Industrial LTDA, Macaçaruru, AM, Brazil). Root canal cement (Endometazone Ivory; Septodont Brasil, Barueri, SP, Brazil) was used as sealer. Afterwards, the teeth were randomly divided into 3 groups of 10 teeth each. Randomization was accomplished by drawing lots.

Post preparations were made with a #5 drill (Largo; Dentsply Maillefer, Ballaigues, Switzerland) to remove 5mm of gutta-percha apical to the cemento-enamel junction (CEJ) from each filled canal in Group 1/3 PP (1/3 of root length), 7.5mm in Group 1/2 PP (1/2 of root length) and 10mm in Group 2/3 PP (2/3 of root length).

In all groups, the root canals were restored with prefabricated stainless steel, parallel-sided, serrated posts

with a tapered end (number 5317, Screw-Post, Euro-Post Anthogyr S.A., Sallanches, France). The posts were cemented with glass ionomer (Rely X, 3M Dental Products Division St. Paul-Minnesota, USA). The cement was placed on the post, which was then seated under 9 kg of pressure during 10 minutes. The dentin was etched with 37% phosphoric acid and a bonding agent (Primer-Bond 2.1, Dentsply Ind. Com, Petropolis, Brazil) was placed on it as recommended by the manufacturer. Cores were fabricated in a standardized form using a core-forming matrix (TDV Dental, Pomerode, SC, Brazil), and a composite resin material (Z250 – 3M Dental Products Division St. Paul, Minn)²². The composite resin was placed using the incremental technique. Five increments of the composite resin were applied, each requiring 40 seconds of composite light curing to complete the coronal core. A light-curing device (Ultraled, Dabi Atlante, Ribeirão Preto, SP, Brazil) was used to light cure the composite resin specimens. The light curing tip was positioned at 2 cm from the specimens on top of the core²². Afterwards, each specimen was once again stored in distilled water at 37°C.

All specimens were prepared with a diamond bur (number 3216) (KG Sorensen, Barueri, SP, Brazil) at high-speed with water spray (Super Torque 625 Autofix, Kavo do Brasil Ind. Com. LTDA, Joinville, SC, Brazil). They were prepared for an ideal crown preparation (1.5-mm facial reduction with a chamfer finish line and 0.5-mm chamfered lingual reduction). All finish lines for all specimens and groups were placed at the level of the CEJ. An impression of the tooth was made using a vinyl polysiloxane impression material (Aquasil, Dentsply, Konstanz, Germany) prior to preparation and was used to fabricate the wax pattern. Wax (Kerr Corporation, CA, USA) was then poured into the impression and the tooth inserted into it; after the wax cooled, the impression was removed and the margins were adjusted. The wax patterns were sprued, invested (Cristobalite, Whip-Mix Corporation, Louisville, Ky, USA) and cast in Ni-Cr alloy (Durabond, São Paulo, Brazil). Crowns were luted to the teeth with the glass ionomer cement (Rely X, 3M Dental Products Division St. Paul, Minn., USA).

All specimens were embedded in acrylic resin (Clássico, Artigos Odontológicos S/A, São Paulo, SP, Brazil) poured into molds made of the same material (30-mm height, and diameter of 22mm and an internal space, located in the center of the mold, with diameter of 10mm and 20mm in height). The teeth were embedded along their long axes using a dental surveyor (Bio Art Equipamentos Odontológicos Ltda, São Carlos, SP, Brazil) and placed in a cool water bath during curing of the resin.

Each specimen was fixed in a special apparatus (fabricated by the authors) that allowed it to be positioned at 45 degrees to the buccal/lingual long axis²². The specimens were subjected to loading at this direction in a universal testing machine (Kratos K2000 MP, Dinamometros KRATOS Ltda, SP, Brazil) (Figure 1). A crosshead speed of 0.5mm/min was applied until failure. The load was measured in Newtons (N). Failure was defined as fracture of the core material with displacement from the post head, or when fracture affected

the core or the tooth.

Data were analyzed by one-way analysis of variance (ANOVA) to determine the overall differences among the means of the test groups and the overall variability within the test groups ($\alpha = .05$).

RESULTS

Table 1 summarizes the mean fracture resistance for the 3 tests groups. ANOVA showed there was no significant difference among groups ($P > .05$). In all groups, failures were mainly due to core fracture (1/3 PP – 100%; 1/2 PP - 100%, 2/3 PP – 90%).

DISCUSSION

The results of the present study accepted the null hypothesis because they showed that the increase in post length in teeth restored with prefabricated posts and composite resin core did not significantly increase the fracture resistance of endodontically treated teeth.

In the present study, the best results were obtained with the shortest posts; the longest posts gave the worst results. In the test models, preparation for this post length may have weakened the root considerably more than the reinforcement provided by the cemented post. Leary, et al.¹⁹ showed that preparation for a post weakens the root considerably. In other words, the use of a post, when preparation of the root to receive the post removed a lot of

dental structure, may weaken the tooth more than reinforce it. This may explain why increasing the length of the post did not consistently increase the fracture resistance of roots in the present study. The results of this study are similar to those of Isidor, et al.¹⁷, who showed that the increase in post length when the tooth was restored with prefabricated posts did not increase the fracture resistance of endodontically treated teeth. On the other hand, these findings are not in agreement with those of Standlee, et al.²⁴ and Holmes, et al.¹⁵, who showed that increasing the post length in the tooth results in a more favorable stress distribution along the post, leading to higher fracture resistance.

Analysis of the fracture mode of specimens showed that the most common cause of failure was fracture of the restorative material. The results of this study are in agreement with those of Bowen and Colb⁶, who concluded that composite resin fracture can occur at a lower force than that required to yield root fracture. According to Abdalla and Alhadainy¹ and Pereira, et al.²², the fracture of composite resin core when occlusal force is applied may be a positive occurrence because it could be protective to the supporting root and, consequently, the use of prefabricated posts and composite resin cores is a viable technique for endodontically treated teeth^{2,22,25,28}.

The limitations of this study include its “in vitro” nature, which did not replicate the oral conditions; also, a single load test was used to investigate the fracture resistance of endodontically treated teeth. For more meaningful results, future studies should incorporate thermal cycling of specimens and fatigue loading.

CONCLUSION

Within the limits of this “in vitro” study, the following conclusions were drawn:

1. No statistically significant difference was found in the fracture resistance of endodontically treated teeth among the means of the three groups.
2. The prefabricated post-and-composite resin core groups showed crown composite resin core failure before occurrence of root fracture.

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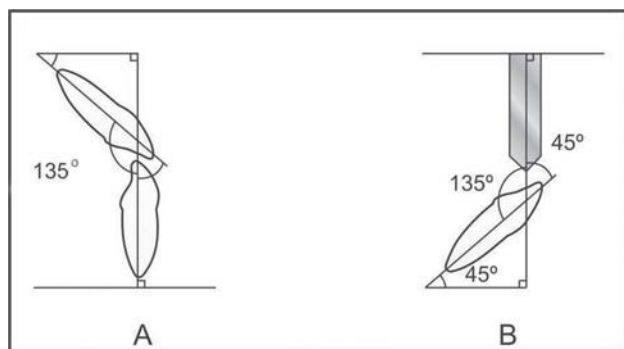


FIGURE 1- The specimens were subjected to load at 45 degrees on a universal testing machine (crosshead speed 0.5 mm/min) (Kratus K2000 MP, Dinamometros KRATUS Ltda, São Paulo, SP, Brazil)

TABLE 1- Resistance to failure values of test specimens, means (N) of test groups and standard deviations

Groups	Mean (N)	SD
2/3 PP	393.8	(81.1)
1/2 PP	395.6	(57.8)
1/3 PP	405.4	(71.4)

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