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ORIGINAL ARTICLE

Fracture Resistance of Endodontically Treated Teeth Restored by Glass Fiber Post and Carbon Post Systems: An *in vitro* Study

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ABSTRACT

Objectives: The purpose of this *in vitro* study was to evaluate the fracture resistance of endodontically treated teeth restored by glass fiber post and carbon fiber post systems.

Materials and methods: About 40 maxillary canines with anatomically similar root segments were taken and then decoronated at the cementoenamel junction. After establishing the working length 1 mm short of the apex, the canal was prepared by the Crown Down technique using rotary protaper followed by obturation. After 24 hours, post space preparation was done using a Peeso reamer. All the specimens were then divided into two groups (group I: Glass fiber post; group II: Carbon post). The posts were then cemented into the tooth using a resin sealer, and acrylic resin cylinders were obtained using cylindrical molds. Specimens were subjected to increasing compressive load (N) until fracture.

Results: There were statistically significant differences observed between the two groups, and it indicated that the glass posts have better fracture resistance capacity.

Conclusion: Within the limitation of this study, it is concluded that the glass fiber posts have better fracture resistance as compared with carbon posts.

Keywords: Carbon post, Decoronated, Endodontically treated teeth, Fracture resistance, Glass fiber post.

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INTRODUCTION

For many decades, the primary concern of the dentist has been to restore endodontically treated teeth.[1] It is known that these teeth are generally weak because of dental structure loss, cavities, filling preparation, and root canal instrumentation. These teeth are thus rendered weak. Moreover, the decrease in the dentin moisture further lowers their strength properties, thus making them more susceptible to fractures. Therefore, it is necessary to take utmost care while selecting the most efficient way to restore them.[2] To ensure a successful restorative outcome, the esthetic, functional, and structural rehabilitation of a pulpless tooth is critically important. When most of the coronal portion is lost, such a tooth should be restored with a post and core, onto which a full crown is cemented. Earlier, the standard option for rebuilding an endodontically treated broken tooth was by using the cast metal post and core. However, today, various tooth-colored posts are available in the market.[3] Today, prefabricated post systems are preferred as they are cost-effective, and, in some situations, less invasive than customized post and core systems, and moreover, they are less time consuming.[4]

Therefore, the purpose of this *in vitro* study was to compare the fracture resistance of endodontically treated teeth restored with two different post systems, namely, carbon posts and glass fiber posts.

MATERIALS AND METHODS

For this study, 40 maxillary canines with straight root canals having anatomically similar root segments and fully developed apices were used. After mechanical removal of soft tissue and calculus from these teeth, they were stored in saline solution. Using a slow-speed diamond disk, the teeth were then decoronated at the cementoenamel junction. After the removal of pulp tissue, the canal lengths were visually established by placing a #10 file into each root canal until the tips were visible at the apical foramen. The working lengths were established 1 mm short of the apex, and the canals were prepared by the Crown Down technique using a rotary protaper (Dentsply, Maillefer). During instrumentation, canals were irrigated with a 5.25% sodium hypochlorite solution and 17% ethylenediaminetetraacetic acid. The canals were dried with paper points, and obturation was completed using a gutta-percha and zinc

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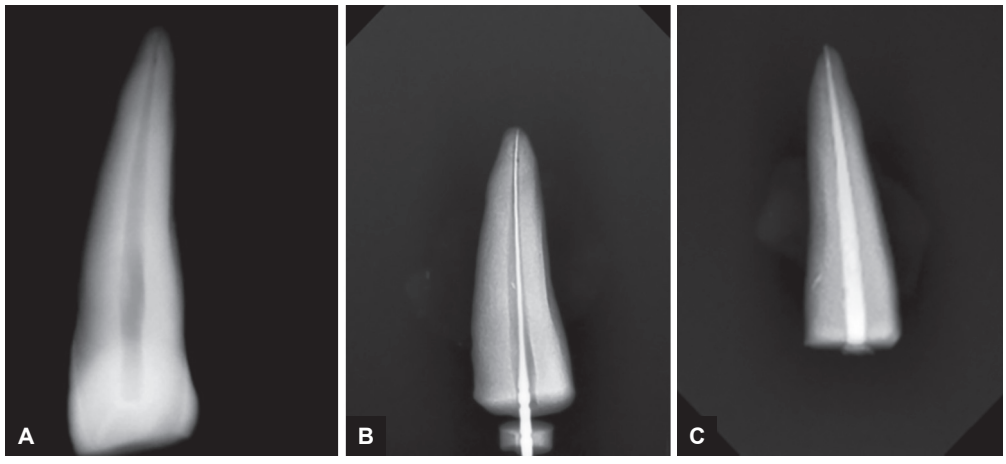
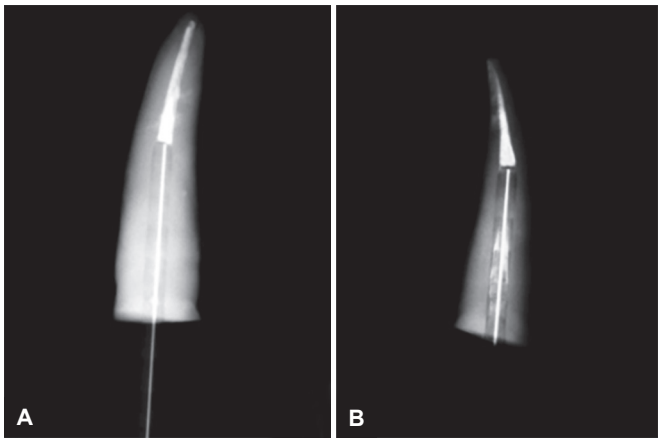


Figs 1A to C: Radiographs of the sample (preoperative to obturation)



Figs 2A and B: Radiograph after post placement: (A) Glass fiber post; and (B) carbon post

oxide eugenol sealer with lateral condensation. A radiograph of each specimen was taken to confirm satisfactory obturation of the canal (Figs 1A to C).

After 24 hours, post space preparation was done using a Peeso reamer, by removing the gutta-percha from the coronal and middle thirds of the roots, leaving behind about 5 mm of intact gutta-percha. Following the post space preparations, the canal was irrigated with saline solution and dried with paper points. The presence of any residual gutta-percha in the walls of the post space was checked by radiovisiography.

All the specimens were then divided into two groups (Figs 2A and B):

- *Group I*: glass fiber post (GF)
- *Group II*: carbon fiber post (CF)

The posts were then cemented into the tooth using a resin sealer and were stored in saline solution at room temperature. Acrylic resin cylinders were obtained using cylindrical molds. The specimens were mounted on the lower plate of the universal testing machine and a compressive loading was applied vertically to the coronal surfaces of the roots with a loading rate of 1 mm/min until fracture occurred. The load at which failure has occurred was recorded and expressed in Newton.

Descriptive statistics including the mean, standard deviation, and standard error were calculated for each of the groups tested. The results obtained were then evaluated using Bonferroni *post-hoc* test. For analyzing differences within groups, Friedman one-way analysis of variance was carried out. Significance for all statistical tests was predetermined at $p < 0.05$.

RESULTS

From the experimental groups, it is known that the glass fiber posts had more fracture resistance than the carbon posts. The mean difference is statistically significant as the observed p-value was less than 0.05 (Tables 1 and 2).

There was significant difference between the two groups, i.e., group I: Glass fiber posts; group II: Carbon fiber posts.

DISCUSSION

It is mandatory to preserve the existing tooth structure while restoring the tooth. An ideal post should provide retention and resistance to displacement of core coupled with esthetics.[5] For many years, the search for dental

Table 1: Mean and standard deviation values

Groups	*Mean*	*Standard deviation*
Glass fiber post	355.87	29.674
Carbon fiber post	267.60	13.405

Table 2: *Post hoc* Bonferroni test

Groups	*Comparison group*	*Mean difference*	*p-value*	*Significance*
Glass fiber post	Carbon fiber post	88.267	0.000	S*

S*: Significant

reconstruction systems that unite resistance, biocompatibility, esthetics, and clinical longevity has been going on, and many alternatives to metal materials, such as metal-free crowns made of pure ceramics, composite resin cores, carbon posts, and glass-fiber posts are now available.[6]

In the current study, glass fiber posts and carbon fiber posts were used.

The first fiber posts were made of carbon fiber, as it had excellent mechanical properties. However, they lack cosmetic qualities as they were black in color.

Torbjörner et al[7] in 1992 reported that a carbon fiber-reinforced post had flexural modulus values comparable to a stainless steel post. Another study done by Isidor et al[8] in 1996 concluded that teeth restored with carbon fiber posts have higher fracture strengths than those with prefabricated titanium posts or cast metal post restorations.

Glass fiber has been used for many years as an esthetic post material. Various *in vitro* studies[9,10] have suggested that the modulus of elasticity of the glass fiber is closer to that of dentin; hence, they might possess some benefits over metal posts.

With an increase in patient's awareness and demands for treatments that are esthetically pleasing, different esthetic restorative materials and techniques have been introduced in dentistry today. In the case of a nonvital anterior tooth that has lost significant tooth structure, a core and possibly a post are required to preserve the integrity of the tooth. In this study, maxillary canines were selected.[11,12] After the crowns were removed with a slow-speed diamond saw at the cementoenamel junction, the obturation procedure was completed, and post space was made.

After the placement of the post, the teeth were loaded in an Instron universal testing machine, and loading was applied to the point of fracture. This represented the worst scenario. However, it does not replicate what it does in the oral environment, where teeth are subjected to forces of mastication that, over a long period of time, may cause fatigue resulting in tooth fracture.

In addition to the masticatory load, in the oral environment, the restored teeth are subjected to numerous challenges including prolonged exposure to moisture, temperature, and pH fluctuations with intake of different foods, and exposure to various bacteria and enzymes. Therefore, these factors may have significant effects on the strength of bonding between the post and the root dentin, which may, in turn, have clinical consequences.[13]

As the laboratory testing cannot exactly simulate *in vivo* conditions, the result, therefore, of any *in vitro* investigation must be viewed with caution. The method evaluated in this study is technique sensitive. Hence, results may vary according to the knowledge and experience of the operator of the technique.

CONCLUSION

Under the limitation of the present study, it can be concluded that among the two post systems used in the present study, glass fiber posts showed the maximum fracture resistance as compared with the carbon posts. However, long-term clinical studies are required to determine the success rate of the glass fiber posts.

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