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ORIGINAL RESEARCH

Comparison of Different Post Systems for Fracture Resistance: An *in vitro* Study

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ABSTRACT

Introduction: 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.

Keywords: Carbon fiber, Compressive strength, Glass fiber, Porcelain-fused-to-metal, Quartz fiber.

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INTRODUCTION

Endodontically treated teeth cause loss of tooth structure and their restoration is an important aspect of dental practice, which needs a range of complex treatment options. Nowadays, cast post–core restorations are the option of choice for endodontically treated teeth,[1] but this kind of restoration, according to many authors, makes teeth fragile and more susceptible to fracture.[2] Prefabricated post systems provide satisfactory results and hence, have become increasingly popular recently.

Endodontically treated teeth result in loss of a significant part of the tooth structure, due to the endodontic treatment. Posts are often required to restore these teeth and to provide retention and resistance for a core material and to provide a coronoradicular stabilization.[3]

The endodontically treated tooth causes loss of the tooth structure and is a unique subset of teeth requiring restoration, and there is change in physical characteristics, such as altered collagen cross-linking, dehydration, the altered esthetic characteristics of the residual tooth, and impairment in neurosensory feedback mechanism. It is critically important to ensure a successful restorative outcome

for esthetic, functional, and structural rehabilitation of a pulpless tooth. In cases where most of the coronal portion is lost, a common method to restore such teeth is the use of a post and core, onto which a full crown is cemented.[4]

The amount of remaining tooth structure, anatomic position of the tooth, functional load on the tooth, and esthetic requirement of the tooth decide about the post placement options. Endodontic posts can be preformed and custom-made; metallic and nonmetallic; stiff and flexible; and esthetic and nonesthetic.[5]

Today numerous tooth-colored posts are available, such as zirconium-coated carbon fiber post, all zirconium, cerapost, fiber-reinforced light post, and glass fiber post.[6] Endodontically treated teeth restored with metal-free, physiochemically homogeneous material similar to dentin has become an essential in dentistry. Root fracture risk is reduced to minimum by fiber-reinforced posts and also revealed significantly higher survival rate. Glass fiber posts integrally bond to the composite core and provide a natural hue, improving the esthetics without compromising much on the strength.[7]

Hence, this study was done to evaluate and compare the compressive bond strength of glass, quartz, and carbon fiber endodontic posts.

OBJECTIVES

- To assess the compressive bond strength of glass fiber posts restored with porcelain-fused-to-metal (PFM) crown
- To assess the compressive bond strength of quartz fiber posts restored with PFM crown
- To assess the compressive bond strength of carbon fiber posts restored with PFM crown
- To compare the compressive bond strength of glass, quartz, and carbon fiber posts restored with PFM crown.

MATERIALS AND METHODS

A total of 45 maxillary central incisors teeth having straight root canals, similar anatomical root segments, and fully developed apices extracted for periodontal reasons were selected for the study from the Department of Oral and Maxillofacial Surgery, S.J.M Dental College and Hospital, Chitradurga, Karnataka, India. Endodontic treatment was performed on all the 45 teeth. A single operator instrumented all root canals to the same size (size 60 file). Canals were irrigated with 1 mL of 5.25% NaOCl during instrumentation. During the instrumentation, the teeth were divided into three groups of 15 each. Lateral condensation method of obturation was carried out using 60-size gutta-percha as master cone. The root canals were dried with paper points before obturation and later obturated with a resin sealer. A lentulo spiral instrument introduced sealer into root canal. Gutta-percha points were coated with the sealer and placed in the root canals to the working length.

Then the teeth were divided into three groups of 15:

- *Group I*: Teeth inserted with the prefabricated glass fiber post.
- *Group II*: Teeth inserted with the quartz fiber post.
- *Group II*: Teeth inserted with carbon fiber posts.

The roots were cut to a uniform length of 14 mm to standardize root canal lengths for the experiment. Cervical root canal openings were then filled with a provisional restorative material. At 37°C the gutta-percha filled root canals were kept for 3 days in a humidor.

The specimens were mounted in acrylic resin blocks, with the long axis of the block, midfacial extent of each tooth parallel to the long axis of the block, and the midfacial extent of cementoenamel junction located 2 mm coronal to acrylic resin. Root length for posts was standardized by reducing the crown of each tooth to a height of 1 mm over the cementoenamel junction.

Peeso reamers removed gutta-percha from the cervical aspect of the root canal. Post spaces were prepared for all the 45 teeth. Post space was standardized measuring 10 mm depth from the cut tooth surface that was taken as the reference point. Post space was prepared using special preparation drills provided by the manufacturer. The posts were placed and core was fabricated using composite restoration followed by PFM crowns cementation adhesive resin.

Testing Procedure

All specimens were placed in artificial saliva for 24 hours before the mechanical experimenting. Universal loading machine measured compressive load required to fracture the tooth. Compressive load was applied at an angle of 130° to the long axis of the tooth, at a crosshead speed of 0.5 mm/minute until tooth fractures. On the small sphere placed on the occlusal surface of the prepared teeth at the long axis of the root, load was applied. Fracture loads were recorded.

One-way analysis of variance followed by Tukey's *post hoc* test was carried out for statistical analysis, and 95% confidence interval with $p < 0.05$ was considered as statistically significant.

RESULTS

Table 1 shows post systems used in the study and the manufacturing company. Table 2 shows the mean compressive strength exhibited by different posts before fracture. The compressive strength exhibited by carbon fiber posts was highest with a mean of 668.33 ± 26.397 followed

Table 1: Post systems used in the study

Sl. no.	*Post system*	*Company*	*n*
1	Glass fiber post	Coltene Whaledent	15
2	Quartz fiber post	Bisco/RTD France	15
3	Carbon fiber posts	Bisco/RTD France	15

Table 2: Comparison of different posts for mean compressive strength

Posts	*Mean ± SD*	*f-value*	*p-value*	*Significance*
Glass fiber post	567.53 ± 26.632	51.121	0.0001	HS
Quartz fiber post	635.80 ± 30.390			
Carbon fiber post	668.33 ± 26.397			

$p < 0.05$; HS: Highly significant; SD: Standard deviation

Table 3: Multiple comparisons using Tukey's *post hoc* test

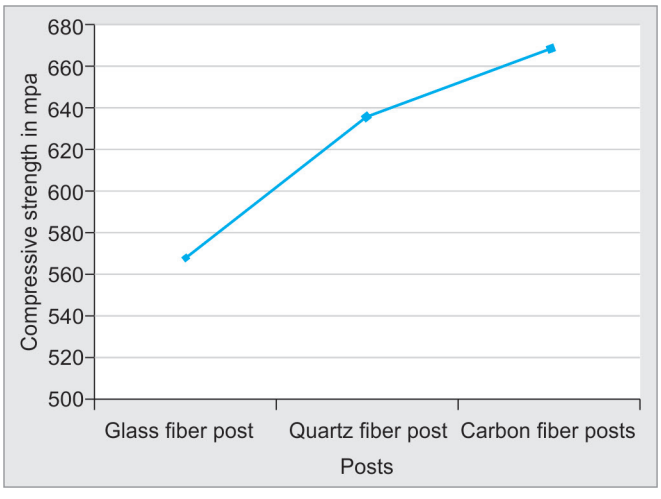
				95% Confidence interval	
Posts	*Compared with*	*Mean difference*	*Significance*	*Lower bound*	*Upper bound*
Glass fiber post	Quartz fiber post	68.26*	0.0001	92.9880	43.5453
	Carbon fiber post	100.80*	0.0001	125.5214	76.0786
Quartz fiber post	Carbon fiber post	32.53*	0.007	57.2547	7.8120

*The mean difference is significant at the 0.05 level

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 depicted a statistically highly significant difference ($p < 0.005$) among the posts used. Table 3 shows the multiple comparisons using Tukey's *post hoc* test among different posts. Tukey's *post hoc* test revealed a statistically significant difference between glass fiber post *vs* quartz fiber post, glass fiber post *vs* carbon fiber posts, and quartz fiber post *vs* carbon fiber posts ($p < 0.05$). Graph 1 shows mean compressive strength among different posts as measured by universal testing machine.

DISCUSSION

The endodontical treatment implies a cavity preparation that gives endodontic instruments "straight line" access into the canal space. This means that more sound coronal and radicular dentin must be removed for efficient cleaning and shaping of the root canal system from which the concept of "crown down" came into existence in endodontic therapy. Therefore, the evaluation of whether a post is needed is based on how much natural tooth substance remains to retain a core buildup and support the final restoration after caries removal and endodontic treatment are completed.[8]



Graph 1: Mean compressive strength among different posts

Crown was prepared for all the samples. This was performed taking into account the fact that most of the post and core restorations are clinically followed by full-crown restorations. Cormier stated that a post and core reinforced with full-coverage crown is more fracture resistant than a post alone or a post and core combination.[9] This may be due to the fact that crowns act to evenly distribute applied loads over the core.[10]

Carbon fiber-restored teeth showed significantly reduced failure load than quartz and glass fiber, in a study on fracture resistance of teeth restored with carbon fiber post. The tooth fractures were uncommon and the most frequent site of failure was the post and core interface.[11]

In this study, 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) and least compressive strength was exhibited by glass fiber post (567.53 ± 26.632). It is similar to the study done by Lassila et al[12] who evaluated the flexural properties of five commercially available fiber-reinforced composite posts, such as the Snowpost, carbon post, Parapost, C-post, Glassir, carbonate, and continuous unidirectional glass fiber composite, shaped in the form of a post as control. Results showed that carbon fiber posts have higher flexural strength values than glass fiber posts.

In this study, Tukey's *post hoc* test revealed a statistically significant difference between glass fiber post and quartz fiber post. It is similar to the study conducted by Cohen BI et al,[13] which shows the fracture resistance and structural characteristics of eight different fiber-reinforced post systems with glass and quartz fiber posts. The flexural strength was evaluated by subjecting the test specimens to a three-point bend test until the posts fractured. The results showed flexural strength of quartz fiber to have a statistical difference when compared with other test groups.

Another study was done by Raju SR et al[14] to know the acceptability of quartz fiber posts by evaluating 180 endodontically treated teeth restored with Esthetic-Plus posts, composite core, and a final restoration by all ceramic or metal ceramic crowns over a period of 30 months. The patients were reevaluated at regular intervals of 6, 12, 24, and 30 months follow-up. The failure rate was 1.7% over 30 months, and it was successful to replace the restoration in all failed cases.

The above results clearly elucidate and support the results of this study, which prove that the carbon fiber posts have a greater compressive strength. However, considering the direction of forces acting *in vivo*, further studies need to be done to simulate the complexity of the functional loads in the oral environment.

CONCLUSION

This study concluded that the carbon fiber posts had higher compressive strength than other quartz, glass fiber posts.

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