

An *In Vitro* Comparative Evaluation of Fracture Resistance of Custom Made, Metal, Glass Fiber Reinforced and Carbon Reinforced Posts in Endodontically Treated Teeth

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Abstract:

Background: Posts are used to enhance crown buildup in pulpless teeth with destructed crown portion. Different types of post are used in endodontically treated teeth. The aim of the present *in vitro* study was to evaluate fracture resistance of custom made, metal, glass fiber reinforced and carbon reinforced posts in endodontically treated teeth.

Materials and Methods: An *in vitro* study was carried out on extracted 40 human maxillary central incisor teeth, which was divided into four groups with 10 samples in each group with custom made, metal post, glass fiber reinforced, and carbon reinforced posts. The samples were decoronated at cemento-enamel junction and endodontically treated. Post space was prepared and selected posts were cemented. The composite cores were prepared at the height of 5 mm and samples mounted on acrylic blocks. Later fracture resistance to the compressive force of samples was measured using Universal Testing Machine.

Results: The maximum resistance to the compressive force was observed in carbon reinforced and glass fiber reinforced posts compared others which is statistically significant ($P > 0.001$) and least was seen in custom fabricated post.

Conclusion: It is concluded that carbon reinforced fiber post and glass fiber posts showed good fracture resistance compared to custom made and metal posts.

Key Words: Carbon reinforced post, custom post, fracture, fracture resistance, glass fiber post

Introduction

Endodontically treated teeth should be restored since there is a loss of structure, changes in physical characters, dehydration and altered esthetic of remaining tooth structure. Post and core with full coronal restoration is a common method to restore coronal portion of lost tooth structure. Dowel is a post placed in the root of a non-vital tooth to retain core portion.¹ Endodontic post can be metallic or non-metallic, custom made or prefabricated, esthetic or non-esthetic. Custom and metallic post was widely used to strengthen the endodontically treated teeth. With increase demand for esthetic and better physical quality, various tooth-colored posts such as glass fiber reinforced post, carbon fiber post, zirconia post, and composite post were developed.^{1,2} Modulus of elasticity for stainless steel and titanium posts are 20 and 10 times greater than dentine, whereas glass fiber reinforced post are bonded to composite core and have modulus of elasticity nearly equal to that of dentine hence reduces possibility of root fracture.² There are very few published studies comparing fracture resistance of the metal and fiber posts. Hence the present study was aimed to compare the fracture resistance of endodontically treated teeth restored with different posts such as custom made, metallic, fiber reinforced and carbon reinforced posts.

Materials and Methods

Totally 40 extracted maxillary incisors free from caries, fracture and cervical abrasion were collected for *in vitro* study and stored in normal saline at room temperature (24-28°C). Root canal treatment, followed by the obturation was carried out on selected specimens. The selected teeth were randomly assigned into four experimental groups with ten in each group (Group A: Custom post, Group B: Stain less metal post, Group C: Fiber reinforced post, Group D: Carbon fiber reinforced post). The samples were decoronated at cemento-enamel junction and endodontically treated. Post space was prepared and selected posts were cemented.

In all groups, post space preparation was done by removing the gutta-percha with peeso-reamer and leaving 4 mm of gutta-percha apically. In Group A, direct inlay pattern of post and core was prepared. The pattern was casted With Type III

cast gold alloy. The post space was treated with chelating agent (Glyde Germany), and subsequently irrigated with 5.25% sodium hypochlorite to remove the smear layer. The post and core were cemented with dual cure adhesive cement (Panvia F, Kuraray, Osaka, Japan). In Group B, C and D after post space preparation, selected posts (stainless steel, glass fiber reinforced and carbon reinforced posts) were cemented with dual cure resin cement and composite core build-up was done to the height of 5 mm.

All specimens were mounted on the acrylic block, and subjected to the compressive force at 1 mm diameter at an angle of 130° to long axis of the tooth using Instron Universal Testing Machine. The force at fracture was measured in MPa. Data were tabulated and statistically analyzed using analysis of variance and *t*-tests (SPSS version 21, IBM).

Results

In the present study carbon fiber reinforced posts and glass fiber reinforced posts showed highest fracture resistance as compared to custom post and metal posts (Table 1). Table 2 showed that there was no significant difference between glass fiber (Group C) and carbon fiber posts (Group D) and between custom post (Group A) and metal posts (Group B, where as between other groups it is statistically significant ($P > 0.001$).

Discussion

Esthetic, functional, and structural rehabilitation of pulpless teeth is critically important for successful endodontic therapy.¹ Clinically, longevity of post-core-crown system for endodontically treated teeth depends on the design, length and diameter of the post, ferrule effect, cementation and amount of remaining tooth substance.² Since many years custom post was used commonly for restoring endodontically treated teeth. Use of prefabricated posts reduced the laboratory and chair side time. Prefabricated posts are as available as metallic or fiber posts. In 1992, glass fiber posts were introduced. Fiber posts are strong, improves esthetics, reduces corrosion and toxicity.^{2,3} Glass fiber posts are composed of unidirectional glass fibers embedded in a resin matrix which

increases the post strength without changes in modulus of elasticity. In a glass reinforced fiber posts stress is distributed in broader surface area, hence reduces the chances of root fracture.²

In the present study, carbon fiber reinforced posts and glass fiber reinforced posts showed highest fracture resistance as compared to custom post and metal posts (Table 1). Table 2 showed that there was no significant difference between glass fiber (Group C) and carbon fiber posts (Group D) and between custom post (Group A) and metal posts (Group B, where as between other groups it is statistically significant ($P > 0.001$).

Results of our study is in agreement with the study by Dean *et al.* *in vitro* study, who observed no root fractures with carbon post, 50 % of teeth had root fracture with cast post.⁴ Similarly Fredriksson *et al.* and Preethi and Kala observed good clinical success with carbon posts and glass fiber posts.^{2,5} Makade *et al.* concluded that, glass fiber post is better compared to metal posts.¹ Our results are consistent with Kantor and Pines, Sirimai *et al.* and Sidoli *et al.*⁶⁻⁸ Robbins recommended use of post to increase the fracture resistance.⁹

Whereas Martinez-Insua *et al.* observed significantly higher fracture strength with cast post and core as compared to carbon fiber posts.¹⁰ Ferrari *et al.* concluded that composite posts systems are superior to cast post and core system, and they observed 14% failure with cast post system.¹¹ Adanir and Belli concluded that for clinical success, posts shorter than clinical crowns should be avoided¹² Jalalian and Mirzaei concluded from their study that, fiber posts with larger diameter adhere to the root structure more efficiently.¹³

Makade *et al.* found that teeth restored with cast post and core found to have cervical and middle third root fracture whereas glass fiber posts demonstrated only core fracture.¹ Garhnyak *et al.* concluded that incorporation of ferrule offered some degree of stress reduction in post restored teeth.¹⁴ Present *in vitro* study helps to know about the physical quality of different types of posts which can be useful in post selection and clinical successful outcome of endodontic therapy.

Conclusion

It is concluded that carbon reinforced fiber post and glass fiber posts showed good fracture resistance compared to custom made and metal posts. This *in vitro* study helps in the selection of posts for successful endodontic therapy.

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Table 1: Mean, median and standard deviation values for fracture resistance in different groups (MPa).

Type of post	Sample	Mean	Median	Standard deviation
Group A	10	857.4	848.3	78.7
Group B	10	1268.7	1272.6	90.2
Group C	10	1213.2	1144.7	141.2
Group D	10	1245.4	1254.5	145.8

Table 2: Comparative evaluation between experimental groups.

Group comparison	t-test value	P value
Group A versus B	0.8061	0.4684
Group A versus C	14.77	0.001
Group A versus D	18.56	0.001
Group B versus C	11.22	0.001
Group B versus D	13.88	0.001
Group C versus D	0.9061	0.3834

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