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:
Fracture resistance of custom made, metal post, glass fiber reinforced and carbon reinforced posts in endodontically treated teeth was measured using compressive force of samples. The composite cores were prepared at the height of 5 mm and samples mounted on acrylic blocks. Later fracture resistance was measured using Universal Testing Machine. 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.

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. 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: Carbon reinforced post, Group D: Fiber reinforced post). The selected teeth were 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 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

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 incisors 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 was measured using Universal Testing Machine.

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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

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Discussion

Esthetic, functional, and structural rehabilitation of pulpless teeth is critically important for successful endodontic therapy. 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. 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. 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.

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 custom post, 50% of teeth had root fracture with cast post. Similarly Fredriksson et al. and Preethi and Kala observed good clinical success with carbon posts and glass fiber posts. Makade et al. concluded that, glass fiber post is better compared to metal posts. Our results are consistent with Kantor and Pines, Sirimai et al. and Sidoli et al. Robbins recommended use of post to increase the fracture resistance.

Whereas Martinez-Insua et al. observed significantly higher fracture strength with cast post and core as compared to carbon fiber posts. 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. Adanir and Belli concluded that for clinical success, posts shorter than clinical crowns should be avoided. Jalalian and Mirzaei concluded from their study that, fiber posts with larger diameter adhere to the root structure more efficiently.

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. Garhnayak et al. concluded that incorporation of ferrule offered some degree of stress reduction in post restored teeth. 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.

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     | 1267.7| 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         | 0.6484    |
| 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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