A comparative evaluation of fracture resistance of endodontically treated teeth restored with metal, carbon fiber post, fiber reinforced post core systems

Running title: Fracture resistance of teeth restored with different post core systems

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Abstract

Introduction: Post-retained crowns are indicated for endodontically treated teeth (ETT) with severely damaged coronal tissue.

Objectives: The evaluate the fracture resistance of endodontically treated teeth restored with metal, carbon fiber post, and fiber reinforced post core systems.

Materials and method: Freshly extracted 45 single-rooted first premolars were included in this study. Usual step-back technique was used to practice a canal preparation for all the teeth. Obturation was done and post space was created with a Peeso reamer. All teeth were randomly allotted into three groups with 15 samples in each group: Group I, metal posts; Group II, carbon posts; and Group III, teeth inserted with reinforced fiber posts. For all teeth core buildup was done using light-cured composite resin. Compressive load needed to fracture the tooth was calculated with a universal testing machine.

Results: The compressive strength value of tested Group I, II and II had 118.56, 26.72 and 243.56 Mpa respectively. The difference was statistically significant (p<0.001). The multiple comparisons of mean values for different posts were statistically significant (p< 0.001).

Conclusion: It can be concluded that carbon post had higher compressive strength followed by fiber reinforced post with higher fracture resistance compared to metal posts.

Key words
Carbon fiber post, fiber reinforced, fracture, post core

Introduction

Esthetic, functional and structural rehabilitation of a pulpless tooth is critically important to ensure a successful restorative outcome. In cases of loss of most of coronal portion, a post and core is a common method to restore such teeth. The post functions principally to help the retention of the restoration and to protect the tooth by dissipating or distributing forces along the tooth. The decision regarding post placement should be based on the amount of remaining tooth
structure, anatomic position of the tooth, and functional load on the tooth and esthetic requirement of the tooth. ¹

Endodontic posts can be either custom made or prefabricated as metallic or non metallic; stiff and flexible and esthetic and non-esthetic type. ¹ Traditionally, prefabricated posts were made with the metal, which sometimes visible through the structure of endodontically treated teeth. ² Today numerous tooth colored posts are available like zirconium coated carbon fiber post, all Zirconium, Cerapost, Fiber reinforced light post and glass fiber post. Fiber reinforced posts are able to reduce root fracture chances. Glass fiber posts integrally bond to the composite core and give a natural hue to improve the esthetics without compromising much on the strength.¹ The prime objectives of post and core procedure are to build missing coronal structure and to provide sufficient retention and resistance form to final restoration. ³

The retention of metal posts are influencened by post shape, surface area, and type of cement used. Parallel posts need more tooth structure to be removed. Tapered and cemented posts need retentive characteristics such as, grooves, threads for sufficient retention. Bonding is used instead of cementing in the newer post systems (fiber-reinforced) for increased retention. Metal post systems have greater chances for causing adverse biologic effects and allergic reactions. Carbon, fiber posts, and glass fiber posts have better biocompatibility, easy to use, esthetics, and corrosion resistance. ²

The present study was done to evaluate the fracture resistance of endodontically treated teeth restored with metal, carbon fiber post, Fiber reinforced post core systems

**Materials and Methods**

The present in vitro study was done in the Department of Conservative Dentistry and Endodontics. Total 45 freshly extracted single-rooted first premolars extracted for orthodontic reason free form cracks, and pathology was included for the study.

To standardize root canal lengths for the experiment, the roots were cut to a uniform length of 12 mm. A usual step-back method was used to prepare a canal for all the teeth. All canals were cleaned and shaped with hand instrumentation followed by irrigation with 2 ml of 5.25% sodium hypochlorite solution and dried with absorbent paper points. Canals were
obturated with gatta percha cones. Canal entrances were sealed with glass ionomer cement and teeth were stored in a saline at 4°C. All teeth were mounted in acrylic resin blocks, so that cementoenamel junction located 2 mm coronal to acrylic resin. After 48 h, the gutta-percha was removed using a Peeso reamer until a depth of 9 mm, leaving 4 mm of gutta-percha at the apex.

All teeth were randomly divided into three groups of 15 samples in each group: Group I Metal post, Group II: carbon post, Group III: fiber reinforced post. Light-cured composite resin, which consists of hybrid BISGMA composite resin of particle size 2–5 mm and weight of 80%, was used for core build up.

**Testing procedure**

All specimens were stored in artificial saliva for 24 hrs prior to the mechanical testing. Compressive load needed to fracture the tooth was calculated using a universal testing machine. Compressive load was applied at 130° angle to the long axis of the tooth, at a crosshead speed of 0.5 mm/min until fracture. Load was applied to a small sphere that was placed on the occlusal surface of the prepared teeth at the long axis of the root. Fracture loads were recorded.

**Statistical evaluation:** The obtained data was tabulated and statistically evaluated using one-way analysis of variance followed by Tukey post hoc test; 95% confidence interval with a $P$ value of less than 0.05 was measured to be statistically considerable.

**Results**

Table 1 indicated the compressive strength value of tested groups. Group I metal post had 118.56 Mp, group II had 26.72 MPa and Group III had 243.56 Mpa value. The difference was statistically significant ($p<0.001$). Table 2 indicates the multiple comparisons of mean values for different posts. The difference was statistically significant ($p<0.001$).
Table 1: Mean compressive strength of different posts

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean value</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I Metal</td>
<td>118.56</td>
<td>32.145</td>
<td>0.0001</td>
</tr>
<tr>
<td>Group II Carbon post</td>
<td>261.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group III Fiber reinforced</td>
<td>243.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test used ANOVA, p<0.001

Table 2: Multiple Comparison between posts

<table>
<thead>
<tr>
<th>Groups</th>
<th>comparison</th>
<th>Mean difference</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Group II</td>
<td>-143.16</td>
<td>0.001</td>
</tr>
<tr>
<td>Group I</td>
<td>Group III</td>
<td>-125</td>
<td>0.001</td>
</tr>
<tr>
<td>Group II</td>
<td>Group III</td>
<td>18.16</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Test used: Tukey post hoc test, P< 0.000 significant

Discussion

A post and core would serve as an ideal solution to re-establish back the strength of fractured root canal treated teeth.\textsuperscript{1} Restoration of the endodontically treated tooth is very important as it has impact on the long-term prognosis of tooth. \textsuperscript{2} Endodontically treated teeth are generally weakened as a result of structure loss due to decay. \textsuperscript{4} Restoring these teeth using materials with similar elastic modulus to dentin appear advantageous due to the reduced risk of root fracture. \textsuperscript{5} A post provides a suitable way to anchor the restorative material to the tooth. \textsuperscript{2} Endodontically treated teeth with inadequate crown structure are usually restored with post and core. \textsuperscript{6} The post is inserted into the root canal of endodontically treated tooth, and thus enables the coronal prosthetic core to be built and retain.\textsuperscript{2} Metal post are relatively consume more time and fail twice as often as prefabricated metal posts and tend to cause non root fractures. \textsuperscript{1}

The present in vitro study was done to evaluate the fracture resistance of endodontically treated teeth restored with metal, carbon fiber post, Fiber reinforced post core systems
Makade et al compared the fracture resistance and the mode of failure of endodontically treated teeth restored with cast post-core, stainless steel post and glass fiber post. They concluded that Endodontically treated teeth without post core system showed the least fracture resistance demonstrating the need to reinforce the tooth. Stainless steel post with composite core demonstrated the greater fracture resistance amongst all the experimental groups. Teeth restored with the Glass fiber post showed the most favorable fractures. 1

Nokar et al evaluated the stress distribution of different post and core materials in radicular dentin by three-dimensional finite element analysis (3D FEA). They concluded that cast post produces lower stress and fiber reinforced post produces higher stress in dentin. 7 Uthappa et al evaluated the clinical success of metal post over fiber post. They concluded that metal post had higher failure compared to fiber post. 2 The findings are similar to our results.

Ramteke et al evaluated the retentive quality of metal post, fiber post, custom posts. They concluded that prefabricated metal post had higher retention compared to other type posts. 8 Ingale et al compared the fracture resistance and the mode of failure of endodontically treated teeth reestablished with various fiber post-center frameworks. They concluded that fracture resistance of group DT light post and Core Flo DC was significantly higher than the other two groups. Control group had the least fracture resistance. 6

Gaikwad et al evaluated the fracture resistance of endodontically treated teeth restored with light-cured composite resin core using two different designs of prefabricated metal posts. They concluded that mean fracture load of parallel post with coronal flare—i post was significantly higher than that of mean fracture load of parallel post—EG post. 9 Dayal et al evaluated fracture resistance of endodontically treated teeth restored by different post system. They concluded that the Zirconia posts had the maximum fracture resistance followed by Glass fiber posts and Carbon fiber posts. 4 Miglani et al evaluated the fracture resistance of an endodontically treated teeth restored with different post and core systems. They concluded that EverStick posts showed the maximum fracture resistance as compared with the carbon fiber posts and custom-made post. 5

Chauhan et al evaluated the fracture resistance of custom made Post and ever StickPOST system in endodontically treated teeth. They concluded that the Everstick posts had the maximum fracture resistance as compared to the custom made post. 10 Moyin et al evaluated the
fracture resistance strength of different post systems in endodontically treated teeth. They concluded that Zirconia posts showed the maximum fracture resistance than the carbon posts and everStick posts.\(^3\) Taheri et al evaluated the effectiveness of conventional posterior composites, and short fiber-reinforced composites with and without the use of glass fiber post (GFP) and polyethylene fiber post on fracture strength. They concluded that higher fracture resistance values were observed with groups restored with the post as compared to groups restored without post.\(^{11}\) Turker et al evaluated the fracture resistance and the mode of fracture of endodontically treated teeth restored with different fiber posts and all-ceramic crowns. They concluded that mean fracture resistance values of the Snowlight thick samples were found to be higher than those of the Snowlight thin samples.\(^{12}\) Revathi et al compared the fracture resistance of ETT restored with two anatomic post systems elastic FRC post (everStick) and self-adapting PFS (Spirapost). They concluded that fracture resistance of PFS was comparable to that of FRC post.\(^{13}\)

The preference and popularity of carbon and fiber reinforced posts can be attributed to its elastic modulus which is similar to that of dentin.\(^{13}\) We found higher compressive strength with carbon posts followed by fiber reinforced post and lower strength with metal post. Hence tested carbon and fiber reinforced post posts can be used clinically to improve the endodontically treated teeth to improve the fracture resistance. The drawback of the study was only 3 types of posts systems were evaluated and the study was in vitro evaluation. Further in vivo studies are needed to evaluate the different post systems.

**Conclusion**

It can be concluded that carbon post had higher compressive strength followed by fiber reinforced post and having higher fracture resistance compared to metal posts.

Conflict of interest: Nil

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References


9. Gaikwad AM, Shah N, Ram SM. A Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth restored with Composite Resin Core using Two Different


