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Assessment of fracture resistance of stainless steel post, Carbon fiber post and ceramic post in endodontically treated teeth: A comparative study

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Abstract
Background: Endodontically treated teeth present a high-risk of biomechanical failure due to the loss of tooth substance resulting from pre-existing decay and endodontic therapy itself. Many non-metallic prefabricated posts have been introduced such as fiber based posts with excellent physical properties. Hence; the present study was undertaken for assessing and comparing the fracture resistance of stainless steel post, Carbon fiber post and ceramic post in endodontically treated teeth.
Materials & methods: A total of 45 freshly extracted maxillary canines were enrolled in the present study. Biomechanical preparation was done in all the specimens followed by obturation with lateral condensation technique. After preparation of post space, all the specimens were broadly divided into three study groups depending upon type of post used- Stainless steel post, Carbon fiber post and Ceramic post. By using adhesive resins, cementation of the posts was done using adhesive resins. After cementation, all the specimens were stored in normal saline for 24 hours followed by mechanical testing under universal force testing machine. All the results were recorded in Microsoft excel sheet and were analysed by SPSS software.
Results: Mean force required for fracturing specimens of stainless steel post group was 523.86 N. Mean force required for fracturing specimens of Carbon fiber post group and Ceramic post group was found to be 459.12 N and 376.67 N respectively. In the present study, while analysing statistically, it was seen that stainless steel posts had highest fracture resistant followed by Carbon fiber posts. Fracture resistance was found to be minimum for ceramic post.
Conclusion: Stainless steel posts exhibit maximum resistance to fracture in comparison to carbon fiber posts and ceramic posts.

Keywords: Stainless steel, Carbon, Ceramic

Introduction
Endodontically treated teeth present a high-risk of biomechanical failure due to the loss of tooth substance resulting from pre-existing decay and endodontic therapy itself. In treating these teeth, intra radicular posts are recommended to aid in the retention of artificial crowns and support the teeth by distributing intraoral forces along the roots. Different post systems have been proposed over the years, from the early cast metallic posts to the pre-fabricated metallic posts or the more recently introduced, translucent fiber posts (FP). Post and core protect or strengthen the tooth against intraoral forces by equally distributing torquing forces within the radicular dentin to supporting tissues thus dispersing forces along the root and providing retention for the core that replaced the lost coronal tooth structure and thus retain the restoration [1- 3].

In recent years, many non-metallic prefabricated posts have been introduced such as fiber based posts with excellent properties like the biocompatibility with different core materials, fatigue and corrosion resistance and high tensile strength, which are considered as a substitute for metallic prefabricated posts. Currently, the available fiber-based posts consist of fibers of carbon or silica surrounded by a matrix of polymer resin. The silica-fiber posts, being translucent and more tooth colored, are also called glass-fiber and quartz-fiber. Fiber reinforced composite posts are available in both prefabricated and customized forms [4-6]. Hence; the present study was undertaken for assessing and comparing the fracture resistance of stainless steel post, Carbon fiber post and ceramic post in endodontically treated teeth.

Materials & Methods

The present study was conducted for assessing and comparing the fracture resistance of stainless steel post, Carbon fiber post and ceramic post in endodontically treated teeth. A total of 45 freshly extracted maxillary canines were enrolled in the present study. Exclusion criteria included.

Deformed teeth

- Carious teeth
- Grossly decayed teeth
- Teeth with presence of developmental anomaly

Biomechanical preparation was done in all the specimens followed by obturation with lateral condensation technique. Obturation was carried out using 40 size gutta percha as master cone. Reduction of crown height was done extending up to one mm above cement enamel junction. In all the 45 specimens, preparation of post space was done. After preparation of post space, all the specimens were broadly divided into three study groups depending upon type of post used Stainless steel post, Carbon fiber post and Ceramic post. By using adhesive resins, cementation of the posts was done using adhesive resins. After cementation, all the specimens were stored in normal saline for 24 hours followed by mechanical testing under universal force testing machine. All the results were recorded in Microsoft excel sheet and were analysed by SPSS software. Student t test was used for evaluation of level of significance.

Results

In the present study, a total of 45 freshly extracted maxillary canines were enrolled. Mean force required for fracturing specimens of stainless steel post group was 523.86 N. Mean force required for fracturing specimens of Carbon fiber post group and Ceramic post group was found to be 459.12 N and 376.67 N respectively. In the present study, while analysing statistically, it was seen that stainless steel posts had highest fracture resistant followed by Carbon fiber posts. Fracture resistance was found to be minimum for ceramic post.

Table 1: Mean force required for fracturing

Group	Mean (Newton)	SD
Stainless steel post	523.86	49.52
Carbon fiber post	459.12	37.16
Ceramic post	376.67	22.94

Table 2: Comparison of mean force

Group	T value	P-value
Stainless steel post versus Carbon fiber post	13.85	0.00 (Significant)
Carbon fiber post versus Ceramic post	27.49	0.01 (Significant)
Stainless steel post versus Ceramic post	21.88	0.00 (Significant)

Discussion

Endodontically treated teeth often present with compromised crown structure, which need full-coronal restoration along with post and core restorations. Endodontically treated teeth present with dehydration, altered aesthetic, and change in physical characteristics. Hence, successful outcome of pulp-treated permanent teeth needs proper rehabilitation procedure. Post is required to restore radicular part of teeth and core to enhance coronal structure. The prime objectives of post and core procedure are to build missing coronal structure as well as to provide sufficient retention and resistance form to final restoration. In earlier days, custom-made post and core restoration was one of the popular methods to restore endodontically treated teeth. Later on, prefabricated posts gain importance due to reduced time and feasibility [7- 9].

In the present study, a total of 45 freshly extracted maxillary canines were enrolled. Mean force required for fracturing specimens of stainless steel post group was 523.86 N. Mean force required for fracturing specimens of Carbon fiber post group and Ceramic post group was found to be 459.12 N and 376.67 N respectively. Amarnath GS *et al.* investigated the in-vitro fracture resistance of devitalized teeth and mode of failure restored with posts of different materials and different lengths. Sixty freshly extracted human mandibular premolars were endodontically treated and then restored with 1 of 2 prefabricated posts: Stainless-steel (SS) and glass-fiber (fiber posts [FP]) with intraradicular lengths of 4, 5 or 10 mm (n = 10). Following core restoration, a static compressive load was applied perpendicular to the long-axis of the teeth. Initial failure of each specimen was recorded in Newton. The mode of failure was also determined radio graphically. Analysis indicated significant differences (P<0.001) among the groups. Among the SS posts, SS/7 (246 N) exhibited the highest failure load and SS/4 (122 N) the lowest. FP/10 (140.5 N) exhibited the highest failure load among the FP and FP/4 (68.5 N) the lowest. SS posts showed post pull out, followed by core fracture while FP showed core debonding, followed by core fracture as the primary mode of failure. Fracture resistance of the teeth proportionately increased with increase in the length of FP while it decreased with that of metal post. SS posts showed greater fracture resistance than FP when 90° load was applied [10].

In the present study, while analysing statistically, it was seen that stainless steel posts had highest fracture resistant followed by Carbon fiber posts. Fracture resistance was found to be minimum for ceramic post. Padmanabhan P compared the fracture resistance and primary mode of failure of three different pre- fabricated posts like stainless steel, carbon fiber and ceramic posts in endodontically treated crowned permanent maxillary central incisors. Root canal treatment was performed on all 30 maxillary central incisors. Post space was prepared and samples were divided into three groups of 10 each. The teeth were inserted with pre-fabricated stainless steel, carbon fiber and ceramic post and cemented using adhesive resins, core fabricated and crowns placed. Mode of failure was carried out by immersing the teeth in black ink for 12 h and then sectioning them mesiodistally. Fracture above the embedded resin was considered favorable and fracture below the resin level was considered unfavourable. There was a statistically significant difference showing that the stainless steel post had a better fracture resistance when compared with the other two posts and the carbon fiber showed a statistically more favorable fracture when compared with the other two posts. Pre-fabricated stainless steel post exhibited a significantly higher fracture resistance at failure when compared with the carbon fiber post and the ceramic post [11].

Conclusion

From the above results, the authors concluded that stainless steel posts exhibit maximum resistance to fracture in comparison to carbon fiber posts and ceramic posts. However; further studies are recommended.

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