Effect Of Different Post Systems on The Fracture Resistance of Endodontically Treated Anterior Teeth: An In-Vitro Study

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***Abstract*—Introduction: Endodontically treated teeth are at higher risk of fracture than vital teeth due to the decreased moisture content in dentin. For functional and esthetic concerns, complete coverage crown restorations along with post and core are often recommended. The objective of a post-endodontic restoration is to achieve normal form and function as well as prevention of root fracture.**

Materials and methods: 140 extracted maxillary central incisors with single canal were divided into 7 groups as group A – control group, group B – Cast post, group C – Carbon fiber post, group D- Glass fiber post, group E- Quartz fiber post, group F- Zirconia post, each group having 20 samples. Root canal treatment was performed on all samples except in control group. Post cementation and core build up was done for all prefabricated posts. All the samples were mounted on acrylic blocks and loaded under universal testing machine. The load at which failure occurred was recored in newton. One way ANOVA test was performed to compare the fracture resistance of seven different post system (N).

Results: The highest difference for fracture resistance was found between cast post and control group and the least significant difference was found between carbon fiber post and zirconia post.

Discussion: Endodontic treatment does save the tooth but in turn the tooth becomes weaker as compared to a normal vital tooth. For functional and esthetic concerns, complete coverage crown restorations along with post and core are often recommended. The posts and core systems can be divided into cast posts and prefabricated posts. There are some disadvantages associated with conventional post and core systems such as poor retention of the post, while prefabricated post is easy to use.

***Index Terms*—quartz fiber post, universal testing machine**

I. INTRODUCTION

Restoration and reinforcement of endodontically treated teeth although practiced for many years, still remains a major concern in dentistry as it is an important step of dental practice in preventing fracture of the teeth.(1) Endodontically treated teeth are at higher risk of fracture than vital teeth due to the decreased moisture content in dentin and most of the times compromised structural integrity.(2) For functional and esthetic concerns, complete coverage crown restorations along with post and core are often recommended.(3) The primary objective of post and core built up is to replace the missing coronal tooth structure sufficiently to provide the required retention and resistance form for final restoration. Post and core protect or strengthen the tooth against intraoral forces by equally distributing torquing forces within the radicular dentin to supporting tissues, post dispersed the forces along the root and provides retention for the core replacing the lost coronal tooth structure and thus help in retaining the restoration. (3,4 (5) The objective of a post-endodontic restoration is to achieve normal form and function as well as prevention of root fracture. Other considerations include esthetics, prevention of caries and retention of final restoration. Their use not only promotes the union and retention between the prosthetic crown and the remaining radicular structure but also prevents the passage of microorganisms and organic liquids to the interior of the root canals. (6)

The topic of posts for endodontically treated teeth has received considerable attention in the literature. The restoration of endodontically treated teeth with metal free, physiochemically homogenous materials that have physical properties similar to those of dentin has

become a major objective in dentistry. This in vitro study was designed to evaluate the fracture resistance of six different post systems in endodontically treated teeth

II. MATERIALS AND METHOD

One hundred and forty freshly extracted maxillary central incisor teeth with single canal, free of caries were collected as samples. The samples were divided into seven groups as group A – control group, group B – Cast post, group C – Carbon fiber post, group D- Glass fiber post, group E- Quartz fiber post, group F- Zirconia post.

The root canal was prepared using sequential endodontic file from No.10 up to size of No. 60. Obturation was done using gutta-percha and endodontic sealer (Zinc oxide eugenol) by Lateral condensation method. The post space prepared using pesso reamers no. 2 & 3 sequentially to a depth of 2/3 the root length.

Cementation of post:1. Group B Specimen: Custom made Post and core were obtained from acrylic resin patterns of root canal. After casting, they were adjusted and adapted to their respective post spaces. The post space was etched with 37% orthophosphoric acid for 20 sec, irrigated with water, dried and primer was applied and cured. Resin cement (U-200) was applied, cast post was coated with resin cement and inserted into the canal with hand pressure for 5 minutes and allowed to cure. Excess cement was removed.

2. For all the specimens in group C, Group D, Group E, Group F: Trial insertion of the post was done to check the accuracy of the fit. The post space was etched with 37% orthophosphoric acid for 20 sec, irrigated with water, dried and primer was applied and cured. Resin cement (U-200) was applied on prepared walls of canal using a spreader. All post were coated with resin cement and inserted into the canal with hand pressure and allowed to cure. Excess cement was removed.

3.Group G: Zirconia posts were Prefabricated using computer-aided design/ computer-aided manufacturing (CAD/CAM) technology. cemented with dual cure-polymerizing composite resin cement.

Tooth sample were then mounted in acrylic resin block. Core build-up for prefabricated post was done after mounting of samples.

The specimens were positioned in a customized jig. The samples were then loaded from buccal surface of the core at 135º to the long axis and 3mm from tooth core interface. Using a universal testing machine with 2mm diameter rounded loading plunger at a cross-head speed of 1mm/min. The specimens were loaded till failure occurred. The ultimate failure load was recorded in Newton(N).

Statistical analysis: Descriptive statistics such as mean and SD were used to present the data. Comparison between more than two groups was done by using ANOVA test followed by post hoc Turkey's Kramer multiple comparison test. A p-value less than 0.05 were considered as significant. The force at which the bond failure occurred was presented as Mean ± SD. One way ANOVA test was performed to compare the fracture resistance of seven different post system (N).

III. RESULTS

The study was conducted to evaluate the fracture resistance of endodontically treated teeth with six different types of posts.

The highest difference for fracture resistance was found between cast post and control group and the least significant difference was found between carbon fiber post and zirconia post.

No significant difference was observed between control group and zirconia post, carbon fiber post and quartz fiber post, glass fiber post and quartz fiber post indicating that they have comparable fracture resistance.

Table no.1- Descriptive data representing mean and standard deviation of fracture resistance of different post and core systems

Groups	N	Minimum (in Newton)	Maximum (in Newton	Mean (in Newton)	Std. Deviation
Control	20	200.36	560.32	309.73	85.37
Cast post	20	963.00	1609.28	1228.93	183.27

Metal post	20	786.20	1241.23	980.42	119.22
Carbon fiber post	20	398.52	880.52	595.33	143.00
Glass fiber post	20	481.52	1006.01	777.68	150.61
Quartz fiber post	20	412.96	956.32	708.77	155.84
Zirconia post	20	760.32	760.32	434.80	134.62

IV. DISCUSSION

After endodontic treatment, the dentist still faces the problem of restoring the crown and reinstating the tooth as permanent, functional, and esthetic member of masticatory apparatus. Endodontic treatment does save the tooth but in turn the tooth becomes weaker as compared to a normal vital tooth. These affected physical properties of pulpless teeth are often attributed to loss of moisture, loss of structural integrity due to endodontic access preparation and changes in collagen cross-linking. (7) For functional and esthetic concerns, complete coverage crown restorations along with post and core are often recommended. (3)

The posts and core systems can be divided into cast posts and prefabricated posts. The cast metal post and core has been the traditional method of restoring endodontically treated tooth. There are some disadvantages associated with conventional post and core systems such as poor retention of the post, greater incidence of root fracture and risk of corrosion when different metals are used in the system. Fabrication of cast metal post and cores can be time consuming and involves additional laboratory cost. The laboratory procedure itself may introduce errors within casting and thus increase risk of failures. These statements cannot be applied to prefabricated post and core systems which have different mechanical properties and the capacity of bonding to dentine with the use of adhesive systems and resin cements. (8)

It was observed in this study that all cast post specimens had more root fractures than core fractures. The fibre group revealed core or post fractures. Posts with higher modulus of elasticity like custom made posts and metal posts are associated with higher failure loads. However, they tend to cause catastrophic and irreparable root fractures when they fail. Being more rigid than the tooth, high modulus elasticity posts produce stress concentration at critical areas of the root and cause more fractures. Al-Omiri et.al reviewed that the mechanical properties of materials used for post construction as well as their biocompatibility may influence the fracture resistance of restored teeth. Unlike rigid posts, posts with a similar modulus of elasticity to dentin like quartz fiber and glass fiber post can distribute stresses more evenly along the post-dentin interface and cause less root fractures.(9) Newman et.al also supports this findings demonstrating highest mean fracture resistance for cast post followed by glass fibre post.(10) In this study, Endodontically treated teeth with prefabricated zirconia post showed lower fracture resistance as compared to cast post and other fiber post systems. These results are in consistent with M. Sadeghi showed that the fracture resistance of cast post-and-core and quartz fiber post was significantly higher than zirconia post. (11)

In order to avoid weakening of teeth by post placement, many post features were thoroughly investigated. Because of the lack of long-term controlled clinical trials and the contradictory results of in vitro studies, the optimum post features are not yet clearly determined. It can be said that a wide variety of factors would influence the survival of posts. The clinician should be selective in choosing the post system that best fits the individual need of each tooth

V. CONCLUSION

Within the limitations of this study, following conclusions were drawn: 1. Cast post has higher fracture resistance as compared to other fibre posts. 2. The mode of failure for cast post was predominantly unfavourable (Root fracture). 3. All the fibre posts showed more favourable failures which were predominantly in coronal region as compared to cast posts. 4. Among the fibre posts, Glass fiber posts showed highest fracture resistance. 5. Among the fibre

posts, Prefabricated zirconia posts showed least fracture resistance.

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