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COMPARATIVE EVALUATION OF RETENTION AND FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH REINFORCED WITH THREE DIFFERENT POSTS SYSTEMS: AN IN VITRO STUDY

Endodontic

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ABSTRACT

Aim: To compare the retention and fracture resistance of three different pre-fabricated posts systems in endodontically treated anterior tooth.
Materials and Methods: Root canal treatment was performed for all the 90 samples used in the study. After the completion of obturation, post space preparation was done accompanied by post cementation. The samples were divided into three groups depending on the post cemented (Stainless Steel, Glass fiber and Ceramic post). The samples were first evaluated for retention with a help of a three-jaw chuck, which grasped the post and tried to pull it out. The force required to dislodge each post was recorded in Newtons. To evaluate the fracture resistance, the samples were subjected to compressive loads at an angle. The load required was then recorded in Newtons.
Results: The mean retention values for Stainless Steel post were significantly greater than those for Glass fiber post and Ceramic post. The mean retention values of glass-fiber post and ceramic post were not statistically different. The fracture load of the post system, it was revealed that highest mean value was seen in Stainless Steel post and was significant than ceramic post and glass-fiber post.
Conclusion: Within the limitation of this study, it can be concluded that the pre-fabricated stainless steel post exhibits a significantly higher fracture resistance and also the retention was more as compared to Glass fiber post and Ceramic post.

KEYWORDS

Post space; Glass-fiber post; Ceramic post; Stainless Steel post.

INTRODUCTION:

Crown of tooth which are lack structural stability after destruction due to caries, fractures or access preparation requires definitive restoration in order to retain in the mouth[1]. It has been the most challenging as the remaining tooth structure becomes very weak after endodontic treatment[2]. The primary aim of treatment to restore such kind of teeth is to provide retention and resistance form for final restoration. For such kind of rehabilitations, post-core system are widely used[3]. Depending on the amount of tooth structure which is left, different post systems are available[4].

Traditionally cast post and core procedures were used but they had disadvantages like time-consuming, expensive, high risk of corrosion and were technique-sensitive. To overcome these drawbacks prefabricated posts came into role which features like rigidity, retention and resistance[5]. Various prefabricated post are available which varies in their designs includes tapered, parallel and threaded designs[6]. The prefabricated metal post or cast post can induce stresses and may result in root fracture as the modulus of elasticity is different from that of tooth[7].

In early 1990s fiber post were developed in order to restore badly broken endodontically treated tooth. These post systems had many advantages over others like high flexural strength, elastic modulus close to dentin, minimal transmission of stresses to the wall of the root canal, thus reducing the risk of root fractures[8]. These post are available as prefabricated and custom-made posts. The custom-made post are made up of no-preimpregnated polyethylene fibers or glass fibers and the prefabricated post are made up of glass, quartz or carbon fibers[9]. The fiber post are biocompatible, easy to manipulated and also are time and cost-effective.

Several studies have revealed that fracture resistance and retention of any post system depends mainly depends upon post type, design and also dimensions[10]. Another important factor which determine the fracture resistance of the root canal treated tooth, is the amount of remaining tooth structure[11].

Selection of an ideal post and core system at the restoration of root-canal treated tooth, increases the life of the tooth and also provides a long term functioning capability of the tooth. Various in vitro studies have been conducted with a view to assess fracture resistance of post systems, but there is little evidence of fracture resistance and retention of newer post systems. Thus, the aim of this in vitro study is to determine the retention and fracture-resistance of endodontically treated maxillary teeth restored with three different post systems.

MATERIALS AND METHODS:

Preparation of the Samples

A total of ninety extracted human permanent single-rooted maxillary canine teeth were used for this in vitro study. Root canal treatment was performed on all the 90 specimens. With 35-size gutta percha (Dentsply) as master cone, obturation was carried out using lateral compaction technique. A resin sealer AH-26 (Dentsply-Kronstaz, Germany) was used in the root canal obturation.

To examine the correct resistance to fracture of the post systems, the crown of each sample was reduced to a height of 1mm above the cemento- enamel junction. Before storing the samples in normal saline for 48 hours they were sealed with cavit.

Post Space Preparation

The preparation of post space was carried out by removing two-third of gutta-percha using #2 Gates Glidden drill (Manni Tochigi-ken, Japan). The flaring of post space was done with #4 pesso reamer (Manni Tochigi-ken, Japan). All the posts were placed to the total depth of prepared post space, i.e., 2/3rd the root length.

Grouping of Samples and post insertion

The teeth samples were divided into three groups. Each group had 30 samples.

Group 1:Pre-fabricated Glass fiber post (Reforpost, Angelus, Londrina, Brazil)
Group 2: Pre-fabricated Ceramic post (Cosmo post, Ivoclar, Vivadent)
Group 3: Pre-fabricated Stainless Steel post (Para post, Coltene and Whaledent, USA)

The canals were thoroughly rinsed and dried with paper point before cementation of the post. The post were cemented using adhesive resins (Luxa core Z-dual-cure resin cement, DMG, Hamburg) according to manufacturer's instructions.

Evaluation of retention of samples:

After preparation of the samples they were placed at 37^{0}C in a highly humid area for 48 hour. The roots of the teeth were embedded vertically in a self-cure acrylic-resin blocks and placed in a Instron machine one at a time. Posts in each sample was grasped and pulled out with a help of three-jaw chuck. Force was recorded in Newtons which was required to dislodge the posts.

Evaluation of fracture resistance of samples:

A compressive load at a crosshead speed of 5mm/min was applied to the root embedded acrylic-resin block using a Instron machine at an angle of 130^{0} to the long axis of the tooth. The fracture load for each post was recorded in Newtons.

STATISTICAL ANALYSIS:

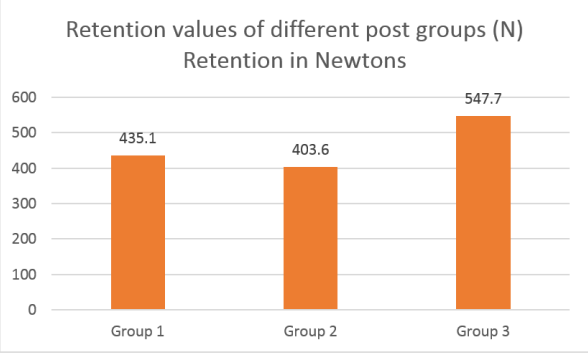
Descriptive and comparative statistics were performed using IBM SPSS v21. Differences among the groups were analysed by Analysis of

variance (ANOVA) tests. P value <0.05 was considered statistically significant for all tests. Variables were expressed as means ± standard deviation.

RESULT:

From the data collected, the mean of retention and fracture resistance of the three posts were collected and analyzed statistically. The result of the present study depicted that both retention and fracture resistance testing showed highly significant difference ($p<0.05$) between the groups.

The mean retention values for Stainless Steel post were significantly greater than those for Glass fiber post and Ceramic post. The mean retention values of glass-fiber post and ceramic post were not statistically different. [Graph 1]



Graph 1: Mean retention values of different post systems

On statistical analysis of the fracture load of the post system, it was revealed that highest mean value was seen in Stainless Steel post and was significant than ceramic post and glass-fiber post. The mean difference is significant at the 0.05 level [Table 1].

Table 1: Mean fracture resistance values of different type of post systems

Groups	n	Mean	Standard Deviation	f-value	p-value
Group 1 (Stainless steel)	30	276.5	28.3	336.5744	0.0000*
Group 2 (Glass fiber post)	30	164.76	15.9		
Group 3 (Ceramic post)	30	156.6	12.1		

*The mean difference is significant at the 0.05 level.

DISCUSSION:

The present study conducted analyzed the retention and load of fracture resistance of three different post system made up pf different materials i.e. stainless steel, glass fiber and ceramic. Same length and diameter was kept for all the samples used in the study. Properties like retention and fracture resistance of the post were selected as, some post like fiber post and ceramic post are more prone to fracture than stainless steel post[12].

In order to achieve a normal form and function of a fractured tooth, post-endodontic restoration are of utmost importance. The remaining tooth structure determines the fracture resistance of an endodontically treated tooth[13]. In this study the posts were evaluated in terms of their retention as one of the most common cause of failure of post and core system is decementation[14]. Another important property with was examined was fracture resistance of the post as metal post have better resistance to load than fiber posts[12].

All the posts used in this study were passive posts i.e. the retention of the post mainly depends on the cement used for luting. In previous studies it has been demonstrated that resin-based cements have greater bond strength as compared to conventionally used cements like zinc phosphate[15]. For this reason resin cements were used as the luting agent in all the sample teeth. The results for retention in our study was different from various studies which have claimed that fiber posts, have a modulus of elasticity quite similar to dentine, owing to homogenous distribution of masticatory loads. However, this cant stand true in case of independent in vitro and any in vivo studies as well[16].

The fracture resistance was evaluated using a Instron machine (Universal testing machine). At an angle of 130° to the long axis of the tooth the sample were subjected to compressive load at a speed of 5mm/min. This value can be accepted but the velocity of mandibular movement varies considerably[17]. The results of the present study in terms of fracture resistance revealed that Stainless Steel post (276.5 N) exhibits the maximum resistance which Ceramic post (156.6 N) showed the least. Stainless Steel post also showed a higher mean fracture resistance than Glass-fiber post, showing that metal post have better properties than rest of the two post systems. Purton[18], Love[19] and Sidoli[17] did similar studies comparing stainless steel post with fiber post and got same results as our study. On comparing fiber post with ceramic post similar results were seen in studies conducted by Maccar[13], Mannocci[20] and Fokkinga[21].

Post material and fracture of roots have a certain association. An ideal post material should have a similar modulus of elasticity as dentin in the root in order to distribute the forces applied evenly along the length of the post and the root[22]. When modulus of elasticity is significantly greater than that of dentin, this can lead to increased stress levels at the tooth/cement/post interface. Various studies have shown that the strength of fiber posts to be lower than metal posts[14]. The modulus of elasticity of tooth is approximately 14-18 GPa. The ceramic post has 170-213 GPa, which is almost 15 times way higher than dentin[23]. Thus, ceramic post can not evenly transmit stresses to root canal leading to root fractures. Resistance to fracture is much greater a property than retention as dislodged post can be recemented but if the root fractures, the has to be removed in any case[24].

Methodologically, the limitation of this study was that the universal testing machines cannot mimic the oblique, torsional and lateral shearing forces produced during chewing. Also that it only duplicates the unidirectional forces which doesn't represent the in vivo situation.

CONCLUSION:

According to the findings and within the limits of this study, it can be concluded that the retention and compressive load on the pre-fabricated stainless steel post (Parapost) was significantly higher as compared to the glass fiber post and the ceramic post.

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