Original Article

DOI: 10.7860/JCDR/2014/7241.4220

Dentistry Section

A Comparative Evaluation of the Retention of Tooth Coloured and Stainless Steel Endodontic Posts: An In-vitro Study

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ABSTRACT

Aims: This in vitro study evaluated: a) the retention of stainless steel posts of 1.5 mm diameter which were cemented with Zinc Phosphate cement versus Glass fiber posts with 1.1 mm, 1.3 mm and 1.5 mm diameters which were cemented with resin cement and b) the effect of change in diameter on the retention of Glass fiber posts with 1.1 mm, 1.3 mm and 1.5 mm diameters.

Materials and Methods: Sixty extracted mandibular premolar teeth were endodontically treated and randomly assigned to four groups of fifteen teeth each. In Groups I, II and III glass fibre posts with diameters 1.1 mm, 1.3 mm and 1.5 mm were cemented by using resin cement. In Group IV, stainless steel posts with diameter 1.5 mm were cemented by using zinc phosphate cement. The specimens were tested for tensile loading at a cross head speed of 2.0 mm/min, on a universal testing machine.

Statistical Analysis Used: One way analysis of variance and Tukey's (post-hoc) test.

Results: Mean tensile strength from highest to lowest was in the order of Group IV, Group II, Group III, Group I. Statistically significant differences were observed between the mean tensile strengths between Groups I and II, Groups I and III, Groups I and IV, Groups II and IV, Groups III and IV, while non significant differences were observed between Groups II and III.

Conclusion: Stainless steel posts were more retentive than glass fibre posts. Glass fibre posts with 1.3 mm or 1.5 mm diameters provided significantly greater retention as compared to 1.1 mm diameter posts.

Keywords: Post technique, Resin cement, Zinc phosphate cement

INTRODUCTION

Endodontically treated teeth frequently receive posts and cores for predictable replacement of lost tooth structure and to gain adequate retention for the final restoration [1-3]. Custom cast posts and cores have been the most accepted treatment mode for many years, and then commercial prefabricated posts with plastic core materials have been a common popular method [4]. Tapered posts which are cemented in their channels are least retentive and they act as wedges, thus causing coronal stress concentration. Parallel sided, serrated, cemented posts distribute stresses evenly through remaining root structure [5]. A variety of metal posts made of stainless steel, nickel, chromium alloy, or titanium alloy have been popularly used, due to their high rigidity and strength [6]. In recent years, various types of fibre posts have been introduced. Since the development of carbon fibre posts in 1990s, demand for better aesthetics has led to the tooth coloured quartz and glass fibre posts. These posts provide aesthetics under all ceramic restorations unlike metallic posts that show as dark shadows at gingival root interfaces [7]. The physical properties (modulus of elasticity, fatigue strength) of fibre posts are closer to those of dentin as compared to metal posts. This helps in absorption of forces which act on the restoration by the posts, with no transfer to the root and root canal walls [8]. Fibre posts help in elimination of corrosion and toxicity from the diffusion of metallic ions. The introduction of resin cements have revolutionized adhesive dentistry [9,10]. Post-retention depends on biomechanical parameters such as cementing medium, length, diameter, shape, configuration, surface roughness and material which is used [10]. The purpose of this study was to compare the retention of the newer glass fibre posts which were cemented by using resin cement, with the conventional system of stainless steel posts being cemented with zinc phosphate cement. Also, the effect of change in diameter on the retention of the glass fibre posts was evaluated.

MATERIALS AND METHODS

Sixty freshly extracted, mandibular, premolar teeth which were free of caries, cracks and fractures, with single straight roots and fully formed apices, were obtained. They were disinfected in 5.25% sodium hypochlorite and stored in normal saline. The teeth were decoronated by using an airotor handpiece (NSK PANA AIR, Japan,www.nsk.com). After access opening, coronal preparation was done by using Gates Glidden drill nos. 1, 2 and 3. Cleaning and shaping was done by using hybrid technique. Normal saline, 5.2% sodium hypochlorite, followed by 17% EDTA (Prevest Denpro limited, Digiana, Jammu, India) were used as irrigants. Obturation was done by using gutta-percha and AH Plus sealer (De Trey Dentsply, Konstanz, Germany, www.dentsply.de) by cold lateral compaction technique. The teeth were randomly assigned to 4 groups of 15 teeth each, as follows: Group I: Glass fibre post (Reforepost, Angelus, dental solutions, Brazil) 1.1 mm diameter, cemented with resin luting cement. Group II: Glass fibre post (Reforepost) 1.3 mm diameter, cemented with resin luting cement. Group III: Glass fibre post (Reforepost) 1.5 mm diameter, cemented with resin luting cement. Group IV: Stainless steel posts (Parapost, Coltene Whaledent Inc., OH) 1.5 mm diameter, cemented with zinc phosphate cement. For the specimens with stainless steel posts, the drill which was provided in the kit was used to prepare the post space. Apical guttapercha allowed to remain was 4 to 5 mm. [11,12]. Posts were adjusted to obtain a snug fit at the depth of 9 mm [13]. After post space preparation, the canals were irrigated with 17 % EDTA solution. The etching of the root canal was done with 37% phosphoric acid for 15 seconds, followed by rinsing with distilled water and drying with paper points, leaving the canal moist. Zinc phosphate cement (De Trey, Dentsply) was mixed on a glass slab, coated on the posts and simultaneously in the canal wall with a lentulo spiral [14,15]. The posts were then seated into the canal and held with finger pressure until the cement was set. The specimens were stored for 24 hours in a sealed glass bottle with moistened gauze, to prevent desiccation. For the glass fibre posts, 3 different size diameter posts were used: 1.1 mm, 1.3 mm, and 1.5 mm. Appropriate size peeso reamer was used for each group to prepare the post space. The apical gutta-percha and intracanal fibre post length were kept similar to those of the stainless steel group. Primer, bond and activator (Contax®, DMG, Chemisch-Pharmazeutische Fabrik GMbH, Hamburg, Germany www.dmg-dental.com) were then applied into the root canal according to manufacturer's instructions by using microbrush (Maxibrush™, Microbrushes Denbur, Inc., Oak Brook IL 60522-3473 USA, www.denbur.com) and teeth were light cured for 20 seconds. The surface of glass fibre posts was prepared by applying one coat of silane coupling agent, Silano (3M Dental Products, St. Paul, MN, www.3M.com) and they were left for 60 seconds for gentle air drying [13]. Further the primer, bond and activator were applied in a similar way as they were applied on the root canal surface. The resin cement (Duoolink™, BISCO, Inc. U.S.A) was mixed on a paper pad and it was applied to the posts and into the root canal. Cemened posts were held firmly, excess cement was removed immediately and they were cured. The specimens were stored like stainless steel posts specimens. All the teeth specimens were mounted on customized acrylic blocks and they were tested for tensile loading on a universal testing machine (Deepak Polyplast Pvt. Ltd., Gujrat, India). Tensile load was applied at a cross head speed of 2.0 mm/min [Table/Fig-1] [13]. Failure load was recorded in kilograms.

RESULTS

Tensile strength values for sixty samples of the four groups were obtained after the testing. Mean failure load (in kg) and standard deviation (SD) were calculated for all the tested groups [Table/Fig-2]. Stainless steel posts cemented with Zinc phosphate cement (Group IV) tended to be the most retentive, with mean tensile force of 45.9 ± 6.2. The next highest retentive group was glass fibre posts with 1.3 mm diameter, which were cemented with resin cement (Group II), which had a mean tensile force of 34.5 ± 7.71. Next retentive group was of glass fibre posts with 1.5 mm diameter, which were cemented with resin cement (Group III), which had a mean tensile force of 32.1 ± 4.87. Least retentive group was glass fibre posts with 1.1 mm diameter, which had a mean tensile force of 20.7 ± 4.08.

Statistical analysis of data, by using analysis of variance (ANOVA) [Table/Fig-3] revealed that there was a highly significant difference between all the four groups for the tensile strength. Therefore, the null hypothesis was rejected.

[Table/Fig-1]: Universal testing machine with mounted specimens after the tensile test

Groups	Mean (kg)	Minimum (kg)	Maximum (kg)	Standard Deviation
Group I	20.7	10.2	26.3	4.08
Group II	34.5	20.6	48.9	7.71
Group III	32.1	24.4	41.3	4.87
Group IV	45.9	37.8	57.9	6.20

[Table/Fig-2]: Mean, range and standard deviation for tensile strength between different groups

Source of variation	Degrees of freedom	Sum of squares	Mean square	f-value	Probability
Between Groups	3	4790	1596.6	46.22**	0.000
Within Groups	56	1934	34.54		
Total	59	6724			

[Table/Fig-3]: One way analysis of variance test (Tensile strength)

Further investigations done by using Tukey's (post hoc) multiple comparison test showed that a highly significant difference existed between the means for tensile strength between Groups I and II (q-value = 9.090, p<0.001), Group I and III (q-value = 7.477, p<0.001), Group I and IV (q value = 16.576, p<0.001), Group II and IV (q-value = 7.486, p<0.001) and Group III and IV (q-value = 9.098, p<0.001), while non significant differences existed between Groups II and III (q-value = 1.612 and p > 0.05).

The results indicated that the stainless steel post group was superior, with highest tensile strength than those of all other groups (p < 0.001). Glass fibre posts with 1.1 mm diameter were inferior, with lowest tensile strength as compared to 1.3 mm and 1.5 mm diameter glass fibre post groups (p < 0.001). Hence, it can be suggested that stainless steel posts were more retentive than the glass fibre posts and that amongst the glass fibre posts, 1.3 mm and 1.5 mm diameter posts were at par with each other.

DISCUSSION

Post retention studies must be completed, to evaluate the retention of newer fibre post systems as compared to the traditional, clinically proven systems such as stainless steel posts which are cemented with zinc phosphate cement. Retention values are a quick and convenient method for comparing the stability of each post. Posts that exhibit greater values are considered to be less likely to loosen when they are subjected to stress. In most studies, tensile force has been used to determine the retention [3,6,16-18].

It has been proved that post length and diameter can influence retention [6,16]. In general, a longer post is more retentive [6,17,18] and for this reason, post length was standardized at 9 mm in this study. Increasing post diameter reportedly does not provide a significant increase in retention for mechanically retained posts [6,18,19]. In contrast, a significantly greater retention was found in this study for 1.3 mm and 1.5 mm fibre posts as compared to the 1.1 mm glass fibre posts which were luted into the preparations with a resin cement. Greater retention of greater diameter fibre posts could have been achieved due to (1) increased surface area for resin bonding (2) greater access for dentin preparation and moisture control in the canal (3) greater post rigidity. For smaller diameter glass fibre posts (1.1 mm), removal of the posts even slightly off the long axis could have caused debonding readily, due to flexibility of these posts.

Because resin cement has the potential to bond to the post and to the tooth structure, the tensile strength values of the bonded posts were expected to be greater than those of the non bonded stainless steel posts. However, in this study, the tensile strength values for stainless steel posts which were luted with zinc phosphate cement were significantly greater than those which were obtained for the glass fibre post group. This finding was similar to the results which were obtained by Purton and Love in which stainless steel Parapost was found to be superior to carbon fibre endoposts [3]. A homogeneous cement with a thin film thickness is of great importance with a passive post, which provides considerable retentive strength. Thus, sufficient tensile bond strength values were obtained with zinc phosphate cement, as the rough surface offered mechanical retention for the cement to set into these interlockings [20].

Because failures of the bonded posts occurred primarily at the resin cement and tooth interface, it was possible that the resin cement must not have effectively bonded to the tooth structure in the root canal. Studies have shown that the formation of a hybrid layer requires preparation of the dentin surface adequately[21-25]. Penetration of the bonding agent cannot occur if the tooth surface has not been prepared adequately, thus leading to lower tensile strengths for the bonded posts. Also, simplified adhesives such as Contax® (DMG) behave as semipermeable membranes that allow fluids to cross the adhesive layer after polymerization [26]. Water may migrate to the composite-adhesive interface and get trapped as water blisters, which may result in debonding at the resin-dentin interface [27]. The intrinsic water that contributes to the stability of the collagen matrix in mineralized tissue can remain inside the extracted teeth, in the dentin tubules [28].

Acid etching and rinsing could have resulted in the retention of a substantial volume of water within the widened tubules. Water may not have been completely removed by absorbent paper points; and it could also contribute to blister growth at the adhesive/resin cement interface [27]. When a bonding surface is left too wet, poor bond strengths may result [29]. Also, the morphology of the tooth structure within the root canal space is not ideal for bonding. Bond strengths are influenced significantly by factors such as depth of dentin and dentin tubule orientation [30,31]. It is therefore possible that the dentin which is present on the surface of the canal space may not form superior bonds with resin. Also, the high "Configuration factor" of the post hole may be responsible for low tensile strength values [27].

The resin cement's greater technique sensitivity could have been responsible for greater variations which occur with its use [32]. The resin cement can be much more difficult to use, as it sets faster, making the seating of posts more difficult than that which is seen with the zinc phosphate cement. Efficient mixing, for reducing voids, would in turn increase the retention of post. This study was limited to one type of resin cement, and other resin systems could more effectively bond to the tooth structure than the one which was used in present study. Future research in this area is indicated.

CONCLUSION

Within the limitations of this study design, the following conclusions were drawn:

1. Stainless steel posts with 1.5 mm diameter and 9 mm length, which were luted with zinc phosphate cement, provided significantly greater retention than glass fibre posts which were luted with resin cement.
2. Glass fibre posts with 1.3 mm or 1.5 mm diameters provided significantly greater retention as compared to the 1.1 mm glass fibre posts.

ACKNOWLEDGEMENTS

The Authors express sincere gratitude to Dr. V. Sai Prasad for his valuable guidance which he offered for the statistical analysis done during this study and to Dr. Suyash Sinha for his continuous help during the study and manuscript writing.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: Aug 02, 2013
Date of Peer Review: Jan 03, 2014
Date of Acceptance: Jan 24, 2014
Date of Publishing: Apr 15, 2014