Original Article

Comparative evaluation of retention of prefabricated and conventional cast post: An *in vitro* study

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Abstract

Background and Objectives: This study was conducted to evaluate the retention of various prefabricated posts and to compare them with that of the conventional cast post. **Materials and Methods:** A sample of 60 freshly extracted single-rooted human mandibular first premolars were sectioned horizontally, 1 mm coronal to the cemento-enamel junction and randomly divided into four groups consisting of carbon fiber posts, glass fiber posts, stainless steel posts and cast metal posts. Cast metal post was the control group. Each group contained 15 specimen. The post space of 9 mm depth was prepared using specific drill supplied by the manufacturer. Resin patterns of the prepared post spaces were fabricated for 15 specimen and were cast in nickel chromium base metal alloy. All the posts were cemented with self-adhesive resin cement and mounted in acrylic cylinders. The teeth were subjected to tensile pull-out test using a universal testing machine. The force required to dislodge each post from the teeth was recorded. The data was analyzed using one-way analysis of variance and Bonferroni test. **Results:** The bond strength of all the prefabricated posts was significantly lower than the conventional cast post. Among the prefabricated posts highest bond strength was obtained for prefabricated stainless steel post and lowest for carbon fiber posts. There was no significant difference in the mean bond strength obtained for stainless steel and glass fiber post. **Conclusion:** Though no single prefabricated post could achieve results close to the control group, most retentive among the experimental group were the stainless steel posts. However, conditions where nonmetallic posts are indicated most preferred type of post can be the glass fiber posts.

Key words: *Bond strength, post, retention*

INTRODUCTION

Endodontically treated teeth often have little remaining coronal tissue and the added loss of coronal structure following root canal therapy often culminates in a situation wherein there is insufficient tooth structure to support an extracoronal restoration.[1] Such teeth may require a post. Custom-cast posts and cores are traditionally used to restore endodontically treated teeth.

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However, various studies have shown that as these metallic materials have a much higher elastic modulus than the supporting dentine the mismatch in the modulus could lead to stress concentrating in the cement lute, leading to failure. Root fracture is also a feature commonly associated with teeth restored with such post systems.[2] Over the years, various prefabricated post systems have been introduced and successfully used in clinical situations which decrease chair time and reduce the cost to the patient. However, there is a continuous need for evaluation of various post systems to make evidence based decision in the clinical context.

Retention of the posts is believed to be essential for the longevity of restorations placed on endodontically treated teeth.[3] Retention values provide a rapid and convenient way of comparing post stability.[4,5] Posts with greater retention are more

resistant to dislodgement as a result of lateral occlusal stresses. Therefore, the present *in vitro* study was conducted to evaluate the retention of three different prefabricated post systems and to assess their suitability for use as an alternative to conventional cast posts.

MATERIALS AND METHODS

Freshly extracted single-rooted healthy human mandibular first premolars, 60 in number were selected. Each tooth was sectioned horizontally with a diamond rotary cutting instrument in a high speed hand piece, 1 mm coronal to the cementoenamel junction perpendicular to the long axis of the tooth [Figure 1]. Roots with distinctly oval canal and diameter of more than 2 mm were excluded from the study. The pulpal tissue was removed and the canal was enlarged with K files up to size 30. 3% sodium hypochlorite solution was used to irrigate the canal throughout instrumentation. All the teeth were randomly divided into four groups. Each group contained 15 specimens [Figure 2].

- Group 1: Carbon fiber posts (Carbonite, Nordin)
- Group 2: Glass fiber posts (Parapost Fibre lux, Coltene Whaledent)
- Group 3: Stainless steel posts (Parapost, Coltene Whaledent)
- Group 4: Cast metal posts.

Figure 1: Teeth sectioned 1 mm coronal to cement-enamel junction

Figure 3: Teeth with cemented posts

Specific post drills for each post supplied by the manufacturer was used for preparation of the post space. A slow speed hand piece was used for this purpose. The post space of 9 mm depth was prepared. Resin patterns of the prepared post spaces were fabricated for 15 specimens and were numbered. All the posts were marked at 9 mm from the apex using permanent marker. Self-adhesive dual cure resin cement was used for cementation [Figure 3]. The specimens were mounted in sectioned aluminum cylinders (12 mm diameter and 20 mm length) [Figure 4] filled with autopolymerizing acrylic [Figure 5]. The acrylic cylinders were separated from the aluminum cylinder. They were stored in water for 24 h and subjected to pull-out bond test.

The acrylic cylinder was attached to the specimen holding jaws of the Hounsfield H10KS, Universal

Figure 2: Various post systems

Figure 4: Sectioned aluminum mold specimen

testing machine [Figure 6]. A vertical uniaxial tensile load (5000 N load cell) was applied to the exposed portion of the dowel with a cross head speed of 2 mm/min until failure occurred. The force necessary to loosen the post was automatically recorded (in Newtons) at the point when the force was of the highest level during the test and the testing was interrupted.

Figure 5: Specimen mounted in universal testing machine

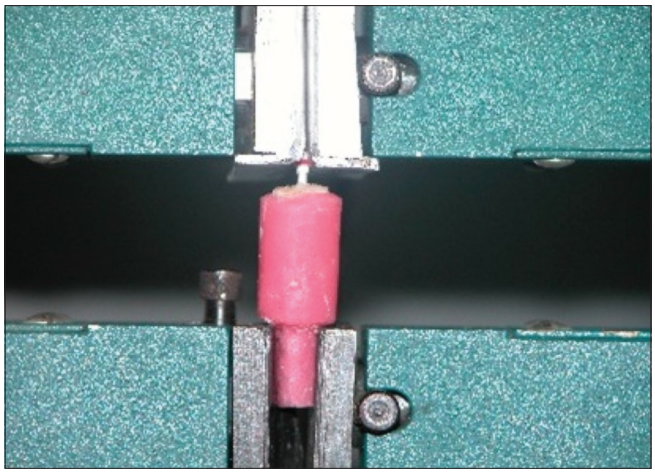
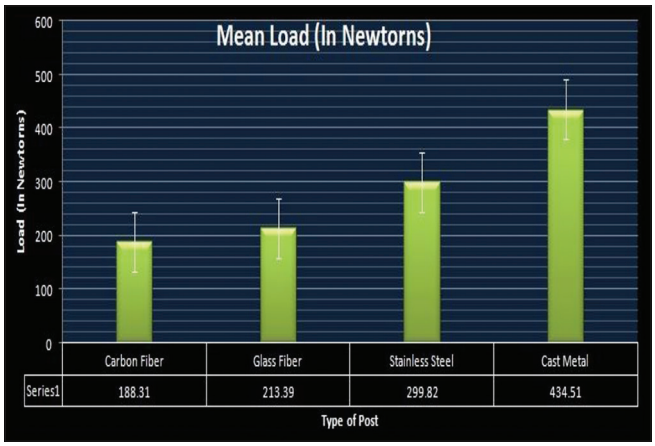


Figure 6: Specimen mounted in universal testing machine (under tensile force)



Graph 1: Mean load of various posts

RESULTS

In order to compare the mean of the four posts [Graph 1] a one-way analysis of variance was done using IBM Incorporation, Statistical Package for Social Scientist, at a level of significance of 0.05 and at a confidence interval of 95%. From the results of the analysis, we observe that there was a significant difference between the posts with respect to the mean load ($F = 20.34$, $P < 0.001$) [Table 1].

In order to find out among which pairs of posts there exist a significant difference, multiple comparisons using Bonferroni test was done [Table 2].

A highly significant difference in the mean load between cast metal and carbon fiber ($P < 0.001$) as well as between cast metal and glass fiber posts ($P < 0.001$) was observed. The difference in mean load between cast metal and stainless steel was also found to be statistically significant ($P < 0.01$).

DISCUSSION

In this study, all the post showed significantly lower retention compared to that of cast metal control group. The results obtained were consistent with those of Wood and Hedlund *et al*.,[6,7] These studies have suggested that a well-adapted cast post and core restoration may be more retentive in function than a prefabricated post and core restoration that does not match the canal shape. Another study done by Stegaroiu *et al*.,[8] showed greater retention of cast post compared to prefabricated stainless steel post upon cyclic loading. Posts are dislodged when the cement fatigues and the bond strength to dentine is eventually lost. Thus, a thick cement layer, especially in the case of prefabricated post may have been more influenced by the cohesive failure within the cement

Table 1: Multiple group comparisons: One-way ANOVA

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	Variance ratio, *F*	*P* value
Between groups	55,5705.8	3	185,235.255	20.374	0.00*
Within groups	509,149.5	56	9091.955		
Total	1,064,855	59			

**P<0.001, a significant difference between the posts with respect to the mean load. ANOVA=Analysis of variance*

Table 2: Multiple comparisons

(I) Post	(J) Post	Mean difference (I-J)	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Cast metal	Carbon fiber	246.2067*	34.8175	0.000	150.973	341.440
	Glass fiber	221.1200*	34.8175	0.000	125.886	316.354
	Stainless steel	134.6933*	34.8175	0.002	39.460	229.927
Carbon fiber	Cast metal	-246.2067*	34.8175	0.000	-341.440	-150.973
	Glass fiber	-25.0867	34.8175	1.000	-120.320	70.147
	Stainless steel	-111.5133*	34.8175	0.013	-206.747	-16.280
Glass fiber	Cast metal	-221.1200*	34.8175	0.000	-316.354	-125.886
	Carbon fiber	25.0867	34.8175	1.000	-70.147	120.320
	Stainless steel	-86.4267	34.8175	0.096	-181.660	8.807
Stainless steel	Cast metal	-134.6933*	34.8175	0.002	-229.927	-39.460
	Carbon fiber	111.5133*	34.8175	0.013	16.280	206.747
	Glass fiber	86.4267	34.8175	0.096	-8.807	181.660

**The mean difference is significant at the 0.05 level. Dependent Variable: Load (Newton), Bonferroni*

layer as compared to the well-fitted cast posts, which have a thin layer of cement around it. This finding could explain the greater retention of cast post. The lowest values of bond strength were obtained for those of carbon fiber posts. The conventional cast posts and the stainless steel posts were retained significantly more strongly than the carbon fiber posts. Sidoli *et al.*,[9] in a similar study found that carbon fiber post and core system exhibited significantly inferior stress values of failure when compared with a well-established conventional cast post and core combination. A comparable result was recorded in a study done by Purton and Love which showed that stainless steel posts were retained significantly more strongly than the carbon fiber posts.[10] Another study done by Purton and Payne showed similar results.[11] Failure at the post/cement interface indicated failure of the cement to adhere to the carbon fiber posts.[12] It appears that any potential chemical bonding between the resin in the carbon fiber posts and the resin luting cement does not achieve a high strength.[13] It is possible that the heat processed carbon fiber posts have little free resin available for chemical reaction. Moreover, the difference in the performance of the two posts was most likely due to the mechanical retention offered by the serrations on the stainless steel posts. Visual inspection of the surface of the cast posts, glass fiber posts and stainless steel posts after dislodgement from the root canals showed that cement was retained on their surfaces, but there were areas free of cements, implying that the mode of failure was a combination of adhesive and cohesive failure. The carbon fiber posts after dislodgement from the root canal showed that there were no remnants of the luting agent on these posts. This implies an adhesive failure at the interface between the cement and the post due to lack of any potential chemical bonding between the cement and the carbon fiber posts.

CONCLUSION

The results of this study showed that the bond strength of all the prefabricated post was significantly lower than the conventional cast post. Among the experimental group, stainless steel posts were the most retentive, whereas the carbon fiber posts were the least retentive. There was no significant difference in the mean bond strength between the stainless steel and glass fiber posts. Though, no single prefabricated post, could achieve results close to the control group, the most retentive among the experimental group was stainless steel post. However, conditions where nonmetallic posts are indicated most preferred type of post can be the glass fiber post owing to their superior esthetic properties.

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