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RETENTION OF CAST POST AND CORE CEMENTED WITH THREE LUTING AGENTS

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ABSTRACT

Purpose: This study investigated the effect of three types of cement materials on the retention of cast post and core and examined the effect of core preparation on the retention of cemented posts.

Materials and Methods: Sixty extracted teeth were subjected to root canal therapy instrumentation and were left unobturated. Post spaces were prepared by Peeso reamers followed by no. 6 parallel-sided Parapost twist drill to a depth of 10 mm. Post and core patterns were fabricated, sprued, invested and cast. The specimens were divided into 3 groups of 20 each. The posts were cemented with zinc-phosphate (Cement Type I), glass-ionomer (Ketac-Cem) or composite resin cements (C&B cement). The specimens were stored in water at 37°C for 24 hours. The specimens were further divided into two subgroups of 10 each used for the prepared and unprepared cores respectively. The core preparation carried out by using a diamond instrument. The post retention was tested using a universal testing machine. A 2-way ANOVA and the Tukey's multiple range test were used to determine the mean differences.

Results: The mean forces required to remove posts from unprepared groups were 482±102 N for zinc-phosphate, 283±88 N for glass-ionomer and 442±98 N for composite resin. The zinc-phosphate and composite resin cements specimens exhibited significantly greater retention forces compared to the glass-ionomer cement specimens (P 0.003) The core preparation only significantly influenced the retention forces for the glass-ionomer cement (P=0.038).

Conclusions: Retention forces of Cement Type I and C&B composite resin cements were significantly greater than those of Ketac-Cem cement after 24 hours of cementation. High-speed preparation 24 hours after cementation had a significant negative effect on the retentive strengths of cast posts cemented with Ketac-Cem, but not posts cemented with Cement Type I or C&B cements.

INTRODUCTION :

A common clinical problem facing prosthodontists is the restoration of endodontically treated teeth that were severely damaged due to caries, fracture, trauma, previous restorations, as well as endodontic procedures. A traditional approach has been to restore the missing tooth structure with post and core. A full coverage restoration is subsequently placed to prevent tooth fracture.[1]

A post is indicated to retain a core that will be used to support the final restoration.[1] In order that the post and core provides retention and resistance for a crown or a retainer, it must be well retained. The retention of the post and core play a major role in the survival of the restoration. Mechanical factors that may affect the retention of a post include the post length, geometric design, surface configuration, and cement type.[1-3]

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Posts, cast or prefabricated, are retained inside the root canal by means of dental luting cement. The cement material enhances retention, aids in stress distribution, and seals the gaps between the tooth and the post.[4,5] The role of cement material in post retention has recently received increased attention because of the significant advancement in the dental adhesive materials.[5-8] The contemporary available luting cements include zinc-phosphate, polycarboxylate, glass-ionomer, resin-modified glass-ionomer, filled and unfilled resin cement.[1] In the past 10 years, several in vitro investigations compared the effect of various cements on the retention of the posts in nonvital teeth.[5-7,9-13] However, as fare as authors knowledge, all these comparisons were carried out using prefabricated post. Custom cast post and core restorations have had a long history of successful use in restorative dentistry.[14] One should expect a better fit and more uniform thickness of cement with cast post and core especially with flared canal. Yet, casting procedure may affect the cast post dimensions[15] which may make these advantages questionable.

Furthermore, none of the previously mentioned retention studies were attempted to do any core preparation prior post dislodgment. Al-Ali et al[16] investigated the effect of coronal preparation on the retention of cast posts and cores cemented with zinc-phosphate cement. They concluded that the core preparation had a significant negative effect on the retentive strengths of posts prepared at 15 minutes and 1 hour after cementation, but not on those tested at 24 hours. Nevertheless, Lund and Wilcox[17] found that crown preparation of cast post and core 1 hour after cementation with zinc-phosphate cement had no significant effect in their retention.

The purposes of this study were (1) to investigate the effect of three types of dental cement materials on the retention of cast post and core and (2) to examine the effect of vibration generated from high-speed handpiece core preparation on the retention of cemented posts.

MATERIALS AND METHODS

The three cement materials tested in this investigation were zinc-phosphate cement (Cement Type I, Confi-Dental Products, Louisville, CO, USA), Glass-ionomer cement (Ketac-Cem, ESPE, Dental-Medizin, Seefeld, Germany) and self-cured composite resin cement (C&B Cement, Bisco Inc, Schaumburg, IL, USA).

Sixty extracted, single-rooted, defects free, human permanent teeth were sectioned 90° to its long axis approximately 2 mm above the facial cemento-enamel junction (CEJ), producing a flat coronal surface. The root canals were subjected to conventional root canal therapy procedures using hand instrumentation with K-files (LD Caulk Division, Dentsply International Inc, Milford, DE, USA) sequentially from size 15 through 45. Each file was used for 5 times prior discarding. The root canals were left unobturated. Post spaces preparation started by using Peeso reamers (Pulpdent Corporation, Watertown, MA, USA) sequentially from no. 1 through 5, to a depth of 10 mm. A new reamer was used for every 10 teeth. The no. 6 parallel-sided Parapost twist drill (Black P-42, Whaledent International, New York, NY, USA) was used to finalize post space preparation. The resultant post space was 1.5 mm in diameter and 10 mm in depth. Water irrigation was used during instrumentation to clean debris from the canal. No. 4 round carbide bur was used to produce a small depression on the coronal surface to help in relining the core during cementation. Radiographs of the specimens were taken mesiodistally and buccolingually to ensure sufficient thickness ($\geq$1 mm) of tooth structure around the post space.

Parapost serrated, cylindrical, vented, plastic burnout post patterns (Black P-50-6, Whaledent) were positioned in the prepared canals to the predetermined depth and cut to leave about 2 mm projection above the canal orifice. Sixty inlay resin (Duralay, Reliance Dental Manufacturing, Worth, IL, USA) core patterns were fabricated using a mold of typical metal-ceramic tooth preparation of maxillary premolar. The inferior surface of each core was hollowed and centrally positioned on the tooth specimen, aligned with its long axis, accommodating the head of the plastic post. The core pattern was connected to the plastic post by means of Duralay resin.

Post and core patterns were sprued, invested using phosphate-bonded investment material (Bellavest T, Bego, Bremen, Germany), and cast in fresh base-metal alloy (Bellabond, Bego) using an induction casting machine (Fornax 35 EUM, Bego). The castings were examined under 10 x magnifications for any casting defects. Each casting was placed on the respective tooth to verify its fit and adjusted if needed using a no. $^{1}/_{2}$ round carbide bur in a high-speed handpiece. Any casting with miscast, uncorrectable defects or unacceptable marginal adaptation was discarded. Finally, the post and cores were sandblasted with 50μm aluminium oxide.

To retain the specimens in the acrylic blocks during testing, the roots were notched and a 0.7 mm diameter hard steel wire was looped through a transverse hole drilled near the apex of each root. The root was embedded into a matrix (25 mm in diameter and 40 mm in lengths) that filled with self-curing resin (Ortho Resin, Dentsply DeTrey, Konstanz, Germany) up to 2 mm below the CEJ. The dental surveyor (JM Ney, Bloomfield, CT, USA) was used when mounting the specimens to ensure that it would be subjected to an axially-directed withdrawal force during testing.

The specimens were randomly divided into 3 groups of 20 each. The posts in the first group were cemented with zinc-phosphate cement, in the second group with glass-ionomer cement and in the third group with composite resin cement. The canal surface preparation, mixing and handling of the cements were accurately carried out according to the manufacturers' instructions. All-bond 2 (Bisco Inc), universal dental adhesive, was used in conjunction with the composite resin cement according to the manufacturer's recommendation. The post was coated with the cement, seated with finger pressure and held in position during the required setting time. The specimens were left undisturbed on the bench for farther 15 minuets prior storage in water at 37°C for 24 hours into a laboratory oven (Imperial IV, Lab Line Instruments Inc, Melrose Park, IL, USA). All specimens were prepared by one investigator.

The specimens in each group were further divided equally into two subgroups of 10 each used for the prepared and unprepared specimens respectively. The unprepared specimens were served as controls. The prepared specimens subjected to core preparation using a coarse, tapered diamond instrument (No. 6836.314.014, Komet, Lemgo, Germany) in a high-speed handpiece with water coolant. A new diamond instrument was utilized for each core preparation. The preparations were preformed freehand by a single investigator. Each core was subjected to 3 minutes axial preparation and 1 minute occlusal preparation.

The posts retention was tested using a universal testing machine (Instron 8500R, High Wycombe, Bucks, UK). A customized, self-aligning testing assembly was used. It includes a U-shaped stainless steel rod with an opening at each end and a horizontal rod that passed through a channel prepared through the lower part of the acrylic block along with the openings of the U-shaped rod. The hook of the lower jaw of the testing machine holds the curve part of the U-shaped rod, while the upper jaw clamped the core (Fig. 1). A tensile load was applied at a rate of 5 mm/min until the post separated from the root. The forces required for dislodgment of the posts were recorded.

The 2-way analysis of variance (ANOVA) and the Tukey's multiple range tests were used to determine the statistical significance of the mean differences between groups. The significance level was set at 5%.

RESULTS

The mean forces required to remove the posts and standard deviations (SD) values obtained with the three different luting cements are shown in Table 1. The 2-way ANOVA showed that the type of cement material significantly influenced the retention forces ($P<0.001$) (Table 2). Tukey's test confirmed that zinc-phosphate and composite resin cements specimens exhibited significantly greater retention forces compared to the glass-ionomer cement specimens ($P \leq 0.003$), which was true for both prepared and unprepared groups. However, there was no significant difference between the zinc-phosphate cement and composite resin cement specimens, which was also the case for both prepared and unprepared groups ($P=0.699$ and 0.632 respectively).

Furthermore, the 2-way ANOVA showed that the core preparation significantly influenced the retention forces ($P<0.006$) (Table 2). However, Tukey's test indicated that this only true for the glass-ionomer cement ($P=0.038$). There was no significant difference between the prepared and unprepared groups for the zinc-phosphate and composite resin cements ($P=0.194$ and 0.106 respectively).

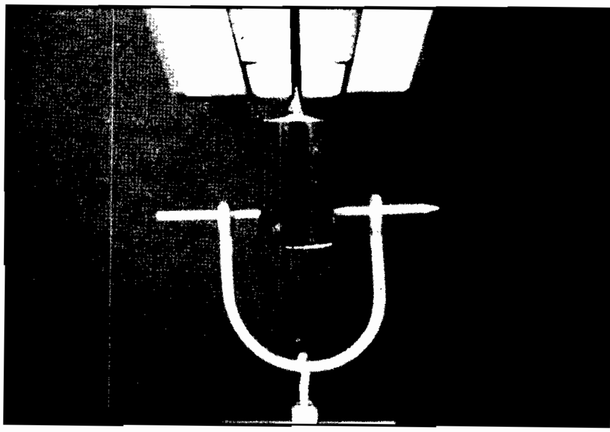

Figure 1. Specimen mounted in the testing machine using the custom-made assembly.

Table 1. Mean and SD of dislodging force in Newton (N =10)

	Zinc-phosphate		Glass-ionomer		Composite resin	
	Prepared	Unprepared	Prepared	Unprepared	Prepared	Unprepared
Mean	410.02	481.50	209.51	283.32	376.18	441.86
SD	132.96	102.08	55.07	88.39	72.89	97.90

Table 2. Two-way ANOVA

	Sum of Squares	df	Mean Square	F	P
Cement material	450192.525	2	225096.262	25.085	0.000
Preparation	74185.491	1	74185.491	8.267	0.006
Cement x Preparation	175.357	2	87.679	0.010	0.993
Error	484568.629	54	8973.493		
Total	1009122.002	59			

DISCUSSION

This study aimed to investigate the effect of cement type on the force required to dislodge cast post and core from a root. The results of this study showed that the retention of the cast post was significantly influenced by the cement type used after 24 hours of cementation. Rosin et al[5] reported similar conclusion with a prefabricated posts.

In order to eliminate a possible variable from the study, the root canals were left unobturated, as the endodontic sealer may affect retentive strength of cemented posts.[7,18,19] Also, Allan et al[20] reported that the root canal sealer may not completely set at 1 week after obturation. A large diameter posts (1.5 mm) was used in this study to overcome another variable, which is the differences in the shape and size of the root canals. Water storage at 37°C was chosen to simulate some factors presented in the oral cavity. Tensile force was used in this study to determine the values required to remove the cast post from the root canal. Although the mode of failure may not directly correspond to the clinical situation, pull-out retention tests are widely accepted and used by most of the studies to evaluate the retentive values of the cemented posts.[5-7,9-13] A search of the literature in the last decade, as far as authors knowledge, revealed no investigations addressed the effect of cement type on the retention of cast post and core. Therefore, comparisons were made with similar studies on passive prefabricated posts.

Forces required dislodging cast posts cemented with Cement Type I (zinc-phosphate) and C&B (composite resin) cements were significantly greater than those of Ketac-Cem (glass-ionomer) cement after 24 hours of cementation. A possible reason for the lower values obtained for the Ketac-Cem specimens is that the glass-ionomer cement may need several days to reach its maximum strength.[21,22] The mean force obtained for Ketac-Cem cement from this study (283±88 N) supports the finding of Love and Purton[9] (286 N) but, is higher than the findings of Cohen et al[10] (106 N) and Duncan and Pameijer[11] (160 N) and lower than the findings of Hagge et al[7] (338 N) and Vargas et al[13] (370 N). However, the later two studies were preformed after longer period of storage time, which may allow farther maturation of Ketac-Cem cement.

The mean force obtained for Cement Type I (zinc-phosphate) cement found in this study (482±102 N) was in the range of the findings of Rosin et al[5] (497 N) and Vargas et al[13] (380 N), but is greater than the values reported by other studies.[6,7,10-12] On the other hand, the mean values found for C&B (composite resin) cement was 442±98 N. This type of cement was not previously tested in the literature. However, this finding is comparable to or higher than that reported for other products of resin cement.[6,7,9-12] In case of resin cement, comparison with previous investigations is difficult due to the broad range reported (179-563 N). The variations may be explained by the lack of standardization in testing methods and materials (e.g. differences in storage duration and environment, bonding methodology, testing techniques, etc.).

Despite the difference in the mean values in this study, the Cement Type I and C&B cements exhibited no significant differences in retention forces of cast post and core after 24 hours of cementation. This result was in agreement with some of previous results.[5,7,18] The large values of SD, which are common in similar studies,[5,9,11-13] have a rule in this result. The reason for this may be that the physical properties or texture of dentin are relatively of a greater variability. Another plausible reason is that during post seating in cementation procedures the cement material pushed out of the root canal leaving some canals surfaces more coated than others. Several studies demonstrated resin cement to be more retentive than zinc-phosphate cement.[6,7,10-12] This certainly does not apply to the two products investigated in the present study. These variations may be explained by the differences in materials properties, storage duration and environment, bonding methodology, and testing techniques.

The results of the present study showed that the zinc-phosphate cement preformed well compared with the two other cements. This should support the recommendation that favor the traditional zinc-phosphate cement as the luting agent of choice for endodontic post.[1,11,12,19,23] This is especially true if the fundamental biomechanical principles were followed. Technique sensitivity and manipulation difficulties of resin cement are often mentioned to support this recommendation.[1,11,12,23]

High-speed preparation 24 hours after cementation had a significant negative effect on the retentive strengths of cast posts cemented with Ketac-Cem. Studies showed that glass-ionomer cement may need several days to reach its maximum strength.[21,22] Therefore, the recommendation comes not to recontour the core with dental handpiece the same day of cementation.[1,24] The present study confirm this recommendation. Core recontour within one day of cementation may disturb the glass-ionomer cement setting and weaken the immature cement. Further study is thus necessary to investigate the effect of preparation on the glass-ionomer cement after more than 24 hours of cementation. Although glass-ionomer cement widely acceptance, the results of this study showed that it is not necessarily the cement of choice for post and cores.

Core preparation preformed 24 hours after cementation had no effect on cast post and cores cemented with zinc-phosphate or composite resin cements. This is in concurrence with Al-Ali et al.[16] They reported that the coronal preparation of cast posts and cores 24 hours after cementation with zinc-phosphate cement had no effect on the retentive strengths of posts. In addition, Lund and Wilcox [17] found that crown preparation of cast post and core 1 hour after cementation with zinc-phosphate cement had no significant effect in their retention.

CONCLUSIONS

Within the limits of the study, the following conclusions were drawn:

1. The type of cement material significantly influenced the forces required to dislodge cast post and cores after 24 hours of cementation.

2. Retention forces of Cement Type I (zinc-phosphate) and C&B (composite resin) cements were significantly greater than those of Ketac-Cem (Glass-ionomer) cement after 24 hours of cementation.

3. The Cement Type I and C&B cements exhibited no significant difference in retention forces after 24 hours of cementation.

4. Core preparation 24 hours after cementation significantly reduced the retention strength of posts cemented with Ketac-Cem.

5. Core preparation preformed 24 hours after cementation had no effect on cast posts cemented with Cement Type I or C&B cements.

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