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EFFECT OF CORE PREPARATION ON THE RETENTION OF CAST POST AND CORES LUTED WITH GLASS IONOMER CEMENT

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ABSTRACT

The objective of this study was to evaluate the influence of core preparation using high-speed handpiece on the retention of cast post and cores luted with glass ionomer cement and tested at 3 different times post cementation. 60 extracted single-rooted human teeth were selected. Root canals were prepared but not obturated. 60 Cast post and cores were then fabricated and luted with glass ionomer cement. Specimens were randomly divided into 2 groups of 30 each. One of these groups (3o teeth) had their cores prepared fora 4-minute period using diamond bur in a high-speed handpiece. This group was then further divided into 3 groups (10 teeth) and each subgroup was tested at 3 different time points (15 minutes, 1 hour, and 24 hours post cementation) while the other group of 30 teeth remained unprepared and divided similarly into 3 groups (10 teeth) to serve as controls. The forces required for vertical dislodgment of posts from their prepared post spaces were recorded using a universal testing machine. Data were statistically analyzed using two-way and one-way ANOVA and the Student's t-test. The retention of the posts significantly increased (from 100 N-to-25 1N) with delaying the time of testing (P<0.0001). In addition, the prepared groups had statistically significant reduction in post retention than the unprepared groups at 15 minutes and at 1 hour (P<0.05). ***Conclusion:*** *Core preparation 15 minutes and 1 hour after post and core cementation significantly reduced post retention statistically.*

Key words: *Post retention, core preparation, cast post and core, glass ionomer cement.*

INTRODUCTION

A number of studies have reported post loosening or dislodgment to be the most common type of post failures.[1-4] Retention of post and core into the root is, therefore, critical for a successful restoration.[5-6] There are several factors that may affect the retention of posts.[7-22] Such factors include post length,[7-10] diameter,[6-10] and design;[7-10] luting agents;[11-16] methods of introducing cement;[11,17] canal lubricant;[18] root canal sealers;[16-20] and timing of core preparation after post cementation.[21-22]

The influence of high-speed handpiece while preparing the core of the cemented cast post and cores is rarely investigated.[21-22] Vibration induced by preparation of the core using high-speed handpiece soon after cementation of the post and core could negatively weaken the cement film between the post and tooth, and hence, may cause post loosening or dislodgement.[22-26] However, Lund and Wilcox (1994) [21] studied the effect of core preparation on the retention of posts 1 hour after cementation with zinc phosphate cement, and found no significant difference in post retention between prepared and unprepared cores. A recent study [22] investigated the effect of the timing of coronal preparation on the retention of cast post and cores luted with zinc phosphate cement. They found that the preparation of the cores at 15 minutes and 1 hour after cementation had significantly reduced the post retention compared to unprepared ones. The

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authors concluded that high-speed preparation of the cores exhibited statistical significant reduction on the retention of posts luted with zinc phosphate cement tested at 15 minutes and at 1 hour post cementation.[22] The reason for different results of the previous studies is mainly attributed to variations in the research design been used in each study.

Among the dental luting agents, glass ionomer cement is commonly used for cementing post and cores.[27-30]o Several authors have reported that this cement requires longer time to reach its maximal retention because of the silicate network reconstruction.3[1-32] As far as the author knowledge, the effect of early core preparation on the post and core cemented with glass ionomer cement has not yet been investigated. Thus, the aim of this study was to evaluate the influence of the core preparation using high-speed handpiece on the retention of cast post and cores luted with glass ionomer cement at three post cementation testing times.

MATERIALS AND METHODS

Sixty extracted, single-rooted intact human teeth were selected. The teeth were cleaned of calculus by hand scaling, polished with pumice/water slurry, and stored in normal saline at room temperature. A straight fissure carbide bur (Komet, Gebr. Brassler GmbH & Co. Kg, Germany) was used to section the coronal portion of each tooth perpendicular to its long axis, approximately 2 mm above the facial cementoenamel junction (CEJ), leaving a flat coronal tooth surface.

Root canals were instrumented to a size 45 with K-files (L.D. Caulk Division, Dentsply International Inc.) but not obturated. Peeso reamers (Pulpdent Corp.) were successively used from no. 1 through no. 5 to a depth of 10 mm. Post spaces were prepared using no. 6 parallel-sided Parapost twist drill (Parapost Black P42, Whaledent International) to 1.5 mm in diameter and 10 mm in depth. All roots were radiographed mesiodistally and buccolingually to ensure that more than 1mm of root dentin thickness remained after preparation.[27] Plastic burn-out post patterns (Parapost Black P-50-6, Whaledent International) were passively placed in the prepared canals to the depth of the prepared post space. The coronal excess of the plastic post projecting more than 2 mm above the canal orifice was then cut away.

Sixty custom molds were prepared by obtaining impression of a typical metal-ceramic tooth preparation on extracted maxillary premolar tooth with medium-body vinylpolysiloxane impression material (Express, 3M Dental Products). Inlay resin (Duralay, Reliance Dental Manufacturing Co.) was poured in these impressions to produce 60 identical core patterns.

The inferior surface of each core blank was flat. With the aid of acrylic bur the inferior surface of core blank was hollowed and centrally positioned on each of the test teeth to accommodate the projecting plastic post. Using Duralay resin each core blank was connected to the plastic post. The patterns ofpost and core were then sprued, invested, and cast in base metal alloy (Bellabond, Bego). Sprues were then separated and cast patterns were examined under 10 x magnification for any casting defects. The fitting of each casting was verified on its respective tooth and adjusted as needed. The post and cores were then airbraded with 50pm aluminium oxide particles.

The roots of the teeth were grooved to increase the retention of roots in the mounted blocks. These were then mounted with self-cure resin (Ortho Resin, Dentsply DeTrey) in the center of a small piece of a PVC pipe (40 mm height and 25 mm diameter). A dental cast surveyor (J.M. Ney Co.) was used to orientate the post space parallel to the vertical axis of the PVC pipe.

One brand of glass ionomer cement (Ketac-Cem, ESPE, Dental-Medizin GmbH&Co. KG, Seefeld, Germany) was used to cement all post and cores in the post spaces. The cement was mixed according to the manufacturer's instructions. To introduce the cement into the canal space a lentulo spiral filler no. 40 (Paste Filler, Sybron Kerr) was used. The post was uniformly coated with cement and slowly seated. A firm finger pressure was then maintained for 8 minutes. Excess cement was carefully removed with explorer.

The 60 specimens were randomly distributed into 6 groups of 10 each (Table 1). Three of these groups served as experimental groups where the specimens were subjected to preparation of their cores at different time intervals (15 minutes, 1 hour and 24 hours) after cementation, using a tapered diamond bur (No. 6836.314.014, Komet GmbH & Co. KG) in a high-speed handpiece with copious water irrigation. Each core was prepared using a new diamond bur. The core prepara-

TABLE 1: MEANS AND STANDARD DEVIATIONS (SD) OF FORCES REQUIRED TO DISLODGE

Study Groups	Mean ±SD
15 min / without preparation	119 ±24[a]
15 min / with preparation	81 ± 14[b]
1 hr / without preparation	184 ±30[f]
1 hr / with preparation	141 ±44[a]
24 hr / without preparation	263 ±80[e]
24 hr / with preparation	240 ±44[e]

Means values designated with the same superscript letter are not significantly different ±P>0.05).

tion was carried out for 3 minutes axial and for 1 minute occlusal. The remaining three groups were not prepared at all and served as controls. All specimens, except the 15-minute groups, were stored in a container of water, placed in a laboratory oven (Imperial IV, Lab. Line Instruments Inc.) at 37°C until tested.

The retention of cemented posts were tested using a universal testing machine (Instron, Model 8500 PLUS, Instron Corporation, UK) with a separating load of 5 mm/min rate. A custom-made device was fabricated to be used in this study. This device consisted of a horizontal rod and U-shaped bar with two small loops at each end. The horizontal rod inserted through a channel prepared into the lower part of mounting block passing through the loops of the U-shaped bar. The upper j aw of the Instron machine clamped the cast core while the lower jaw hooked to the curve of the U-shaped bar. The forces required for post dislodgment were recorded in Newtons.

The data were analyzed with SPSS **10.0** software program for windows (SPSS). Comparison of mean dislodging forces was performed for the preparation and the time factors using two-way and one-way ANOVA and Student's t-test. A result was considered statisti-

RESULTS

In general, the retention of cemented cast posts increased as the time of testing after cementation increased (Table 1). The prepared group tested at 15 minutes and luted with glass ionomer cement had the lowest retention (mean=81 N), while the unprepared group tested after 24 hours had the highest retention (mean=263 N).

Two-way ANOVA revealed a statistically significant difference in mean post retention for unprepared and prepared groups (P=0.003) and for the three testing time points (P<0.0001) (Table 2).

One-way ANOVA showed that there were statistically significant differences among the means of the three unprepared groups (control) (P<0.0001), as well as among all the prepared groups (experimental) (P<0.0001). In addition, for the prepared groups Post Hoc tests found statistical significant differences between 15 minutes vs. 1 hour (P=0.003), between 15 minutes vs. 24 hours (P=0.0001), and between 1 hour vs. 24 hours (P=0.0001). Among the unprepared groups, there were statistically significant differences between 15 minutes vs. 1 hour (P=0.023), between 15 minutes vs. 24 hours (P=0.0001), and between 1 hour vs. 24 hours (P=0.005).

Studying the effect of core preparation on post retention, Student's t-test revealed significant differences in retention between unprepared and prepared groups at 15 minutes (P=0.0001) and at 1 hour (P=0.019). However, there were no significant differences in post retention between unprepared and prepared groups at 24 hours (P=0.420) (Table 1).

TABLE 2: TWO-WAY ANOVA FOR FORCES REQUIRED TO DISLODGE POSTS.

	Sum of Squares	*df*	Mean Square	F	P
Time	231923.826	2	**115961.913**	57.99	0.000
Preparation	18762.017	1	**18762.017**	9.38	0.003
Time x preparation	1061.574	2	**530.787**	.265	.768
Error	107991.342	54	**1999.840**		
Total	2120291.640	**60**			

DISCUSSION

In this study the cast post and cores luted with glass ionomer cement that subjected to core preparation had significantly reduced post retention than those of unprepared cores. This was true for the two time intervals 15 minutes and 1 hour after cementation. However, the core preparation failed to show a significant effect compared to the unprepared ones at 24 hours after post and cores cementation. A previous investigation found similar findings with zinc phosphate cement.[22] One possible reason is that the cement was not completely hardened in the 15 minutes and 1 hour and thus was vulnerable to be effected by vibration induced from high-speed handpiece.[26] The results of the present study showed that preparation of the core with the high-speed handpiece at 15 minutes and 1 hour post cementation could have detrimental effect on the integrity of the cement film by weakening the immature cement, and may results in post loosening. These findings are in agreement with the recommendations of the previous reports that indicated avoiding core preparation soon after post and core cementation.[22-26]

The prepared group tested at 15 minutes required the lowest dislodgement forces. There was 32% decrease in the post retention when compared to the unprepared group. While, the prepared group tested at 1 hour showed a 23% reduction in post retention compared with the unprepared group. These findings agreed with those reported by Al-Ali *et* al.[22] for zinc phosphate cement using a similar methodology.

The results of this study showed that the retention of posts increased as the time of testing was delayed. Generally, post tested after 24 hours showed higher retention than those tested at 15 minutes or 1 hour. This is also in agreement with Al-Ali *et al.*[22], who, reported that the post retention increased with time for both prepared and unprepared post and cores luted with zinc phosphate cement.

Several authors have investigated the setting reaction of glass ionomer cement.[31-32] This cement undergoes a prolonged setting reaction and hardens gradually compared to other dental cements.[33] The complete maturation of glass ionomer cement continues to increase over several days to several weeks or even to about one year. [31-32,34-39] This increase in cement strength with time is thought to be due to the reconstruction of the silicate network. [39-41] The results of this study support this observation, as posts retention increased significantly from 15 minutes to 24 hours.

In the literature, the opinions differ whether glass ionomer cement should be used for luting posts and cores [27-30] or should not be used.[26,42] One of the reason against its use is that cement does not attain adequate strength in its early setting.[45] Moreover, it has been reported that glass ionomer cement with increased film thickness have poor physical properties, producing excessive shrinkage stresses and resulting in cohesive failure of the cement.[46] Mitchell *et al* [47] found that the glass ionomer cement used to lute posts were microcracked before any load application. Under functional forces, these microcracks could propagate, and may leading to catastrophic cohesive failure of the cement and have loosening of the post.[48]

Because cast post and cores luted with glass ionomer cement (Ketac-Cem) showed a very low retentive values at early stage after cementation that increased gradually with time, it is recommended that core preparation should be postponed for at least one day after cementation. However, glass ionomer cement is not the cement of choice for post and cores particularly if immediate core preparation is desired.

In this *in vitro* study, teeth were carefully selected for standardized size and quality. Nevertheless, considerable variations in the post retention which resulted in somewhat high standard deviations were observed. Such variations have been noted in similar previous experimental studies using extracted human teeth.[21,22]

One of the limitations of this study is the use of extracted teeth with no alveolar housing and periodontal ligaments in contrast to teeth in the oral cavity. In addition, teeth in the mouth are subjected to different types of forces such as compressive, shear, torquing as well as tensile stresses. However, this study evaluated only one type of forces which was the axial tensile strength. This test was used to determine the values required to remove the cast post from the root canal. Even though, the tensile pull-out test may not directly correspond to the clinical situation, it is commonly used by most of the studies to assess the retention of the cemented posts.[8-15,21,22]

The results of this study would help the clinicians on timing of core preparation if glass ionomer cement

is used. Whenever cast post and cores luted with glass ionomer cement necessitate core preparation, this procedure should not be carried earlier than 1 hour post cementation.

CONCLUSIONS

Within the limitations of the present study, the following conclusions were drawn:

1 Cast post and core retention increased significantly with the time for all prepared and unprepared groups irrespective of core preparation using high speed handpiece.

2 Cast post and cores subjected to high-speed preparation had statistically significant reduced post retention than those of unprepared cores at 15 minutes and at 1 hour after cementation testing interval.

3 The effect of core preparation performed 24 hours after cementation with glass ionomer cement on the retention of cast posts was not significant.

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