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An *in vitro* Comparison of the Retention of Cast Posts Using Two Kinds of Glass Ionomer Cements

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The aim of this study was comparing retention of cast post luted with two kinds of glass ionomer cement in different time intervals. In this *in vitro* experimental study 60 newly extracted maxillary canine teeth were chosen, the canals were prepared by step-back method and were filled with gutta percha and ZOE sealer. A 12 mm post space was prepared and the posts were made by conventional method using Duralay resin and cast with Supercast alloy. The teeth were divided into 6 random groups, 3 groups were cemented using Ariamix cement and the other 3 groups using GC Fuji 1 glass ionomer cement. The tension test was performed on each group, 20 min, 1 and 24 h after cementation and Instron machine was used for applying tension. Results were analyzed by two-way ANOVA and Tukey tests. The results revealed the fact that the tensile strength had a significant statistical difference between the 20 min, 1 and 24 h time intervals ($p<0.001$). There was no significant difference between two cements between time intervals. The best time interval was 24 h. This study revealed the fact that there was no significant difference between the retention of GC Fuji 1 cement and the Ariamix cement.

Key words: Cast post, glass ionomer cement, retention

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INTRODUCTION

The successful restoration of an endodontically treated tooth with moderate to severe damage is an ongoing challenge for a dentist (Miller *et al*., 1998). In this study, cast posts are used as a method for crown reconstruction (Morgano and Brackett, 1999). The retention of a cast post in a root is critical for the longevity and success of this treatment (Ertugrul and Ismail, 2005). Studies have reported that design, length and character of the surface of endodontic posts have an influence on their retentive properties (Rosin *et al*., 2000). Furthermore, the ability of a luting agent to retain a dowel can affect the prognosis a restoration (Ertugrul and Ismail, 2005; Rosin *et al*., 2000). All cast posts gain their definitive retention by cementation into a prepared root (Ertugrul and Ismail, 2005; Bouillaguest *et al*., 2003). The ability of different luting agents to retain dental posts is related to the mechanical properties and durability of a luting agent to the surface being joined and the configuration of a post and prepared canal (Ertugrul and Ismail, 2005; Bachicha *et al*., 1998; Habib *et al*., 2005). Currently, a large variety of luting agents are available for this purpose, but there aren't any studies about time interval cementation and tensile test.

The purpose of this *in vitro* study was to compare the retentive values of cast posts cemented with two glass ionomer cements, GC Fuji 1 (GC corporation, Tokyo Japan) and Ariamix (By Asia chemi Teb Mfg Co., Iran).

MATERIALS AND METHODS

This study was performed in Mashhad dental school (Iran) in 2006. Sixty maxillary, noncarious canines were selected for this *in vitro* experimental study. Specimens were extracted within the last one month and stored in isotonic sodium chloride solution at 22°C. Teeth were transferred into 5.25% sodium hypochloride solution 24 h prior to preparation and kept these for 10 min. The crowns were cut from 2 mm above the cemento-enamel junction perpendicular to the long axis of the root with a diamond-coated disk (Superflex, Edenta AG Dental produkte, Switzerland) under constant water spray. The root canals were measured with P.A radiography and a No. 10 endodontic file (Kerr/Sybron Corp) and prepared with files and Gate Glidden drills burs by step back technique. Canals were filled with Gutta percha cones (Apadanatak Co., Iran) and ZOE sealer. The post space was prepared with a No. 3 pesso reamer for all specimens, (Maillefer S.A., Ballaigues, Switzerland) to a length of 12 mm from the flattened cut surface. A notch was prepared (2×2 mm) in the thickest part of inside root surface as an antirotation feature and orientation guide (Shilingburg *et al*., 1982). For each specimen, a solid plastic sprue (Williams Sprue; Williams Dental, Amherest, NY) was trimmed so that it could be inserted easily into the canal. The canals were lubricated with Duralay petrolatum and direct post patterns were made by Duralay acrylic resin (Duralay; Reliance Dental MFg Co., Worth, IL). A transverse hole was drilled in the acrylic core to allow attachment to the tensile testing apparatus (ENNE Instron machine). Preparation of the root canal space and fabrication of post patterns were performed by a single clinician. The post patterns were invested in casting rings using phosphate-bonded investment (Aurovest, Bego, Bremen, Germany) without ring liner. Castings were made with a base metal alloy (Supercast, USA) using an centrifuge machine (Kerr) and were allowed to cool to room temperature. The castings were sandblasted with 50 μm aluminium oxide particles and spures were cut. Minor adjustments of the castings were made to allow seating in the prepared canals. The seating procedures were performed by a single clinician. Retentive notches were placed on the outer surfaces of the roots with an inverted cone carbide bur (Diatech Dental, Switzerland) to help retain the root in the acrylic resin block. Each test specimen was fixed with paste to a dental surveyor (J.M. Ney Co.). A plastic box with 2×2×3 cm internal dimensions was placed on the plateform of the survyor and filled with self-cured acrylic resin dough (Meliodent, Bayer, Germany). The vertical arm of the surveyor was lowered until the cut surface of the tooth was flush with acrylic dough surface and was allowed to remain undisturbed until chemical curing of the resin was completed. The posts were rinsed with a detergent solution and dried with compressed air before cementation. Post space was cleaned from petrolatum by acrylic alcohol rubbing and air dried. The specimens were divided into 6 groups of 10 specimens:

- **Groups A, B, C:** GC Fuji 1 glass ionomer cement was applied.
- **Groups D, E, F:** Ariamix glass ionomer cement was applied

Time interval between cementation and tesile test was 20 min for groups A, D and 1 h for groups B, E and 24 h for groups C, F. GC Fuji 1 glass ionomer cement (GC Fuji 1, Corportion Tokyo Japan) and Ariamix (By Asia chemi Teb MFg. Co.) were mixed on a clean slab following

the manufacturer instructions. Cement was introduced into the root canals by Lentulo spiral filler and then post inserted and held in position with 10 kg pressure until the initial set of the cement (10 min). The cementation procedures were performed by a single clinician. Each acrylic resin block was mounted firmly to the lower jaw of a testing machine (NENE Instron machine, England). Tensile testing was performed for all groups according to the mentioned time intervals. The load was gradually increased until the post was withdrawn from the root canal and the force was recorded. Non parametric Kolmogorov Smirnov test was used to determine whether the tensile force variance is normal or not.

To determine the combined effect of cement type and time interval a Two-Way ANOVA test was used. Tukey test was used to compare the difference between 3 time intervals for each cement. In all tests significant level was 0.05.

RESULTS

According to the test results, retention values of cast posts cemented with GC Fuji 1 glass ionomer cement (Mean = 37.1 kg, SD = 5.6) and Ariamix cement (Mean = 36.7 kg, SD = 5.6). The maximum tensile force was in 24 h interval and the minimum was in 20 min. Since two factors affected tensile force and because the response variance was normal, Two-Way ANOVA was used. Results demonstrated that time interval between cementation and tensile test had significant direct effect on tensile force ($p<0.001$, Table 1).

Tukey test showed that the difference in tensile force was significant between 20 min and 1 h ($p<0.001$), 20 min and 24 h ($p<0.001$) and 1 h and 24 h ($p = 0.001$).

Two-way analysis variance also showed that the kind of cement had no significant effect on tensile force ($p = 0.95$, Table 1).

Table 1: Means and standard deviations of tensile test for two cement types and different time point

Time intervals between cementation and test	Cement type	
	GC cement	Ariamix cement
	Mean±SD	
20 min	A: 31.2±2.7	D: 30.1±3.3
1 h	B: 39.6±2.7	E: 38.4±2.3
24 h	C: 42.9±2.8	F: 41.8±2.5
Two-way ANOVA test		
Effect of time interval	F = 97.3 p<0.001	
Effect of cement	F = 2.8 p = 0.95	
Inter action	F = 2.6 p = 0.99	

DISCUSSION

Although the failure measurements in this investigation may not directly correspond to the clinical scenario, it is obvious that they are greater than forces applied in real clinical conditions (Miller *et al*., 1998; Ertugrul and Esmail, 2005; Rosin *et al*., 2000; Bouillaguest *et al*., 2003; Duncan and Pameijer, 1998; Chan and Harcourt, 1993).

Cementation of a cast post into the prepared canal is important because the process achieves a seal along the canal wall that is critical to post retention (Fakiha *et al*., 2001; Leary *et al*., 1995). The Type I glass ionomer cements are designed for cementation of castings. The powder is fine ground with a particle size of 15 μm or less (Phillips, 1991). The glass ionomer luting cements bond to tooth just as polycarboxylate cement, via a reaction of the carboxyl groups of the polyacid with the calcium in the tooth (Phillips, 1991). Glass ionomer cements are known to require several days and even several weeks to reach maximum strength (Morgano and Brackett, 1999; Rosin *et al*., 2000) but we couldn't find any study about time interval between cementation and tensile test.

The ability of different luting agents to retain cast posts is related to many factors such as: diameter, length, configuration and fitness of post, antirotational groove, luting cement type, clinician ability etc.

In this study three time intervals were chosen for tensile strength test after post cementation, 20 min, 1 and 24 h. Regarding the statistical analysis of the data, there was no correlation between cementation and time. In other words, both cements acted the same way. Regarding time, minimum retention was observed in 20 min groups (A, D) and maximum retention in 1 h groups (B, E) and 24 h groups (C, F). GI cements form chemical bonds with tooth structure. Bonding mechanism consists of ion exchange between the cement (calcium ion) and tooth structure (phosphate ion) (Powers and Sakagushi Ronald, 2006). Setting and bonding in glass ionomer cement takes places in two steps and has a long process, producing calcium salts is the initial step of setting. Eventually, Aluminium ions are converted into aluminium salts and the cement becomes harder (Powers and Sakagushi Ronald, 2006). Regarding the mentioned factors, minimum retention in both cements (20 min groups) is due to deficient chemical bonds with tooth structure. In this step, tensile stress harms the bonds. With the completion of setting reaction in 1 h, more force is needed to remove the post. In 24 h, chemical bonding is fully completed so the removal force may be even more. Mendoza and Eakle (1994) demonstrated that a glass ionomer cement (ketac-Cem)

was equally or more retentive than panavia and All-Bond 2 resinous cements, respectively and 30.43 kg force was required to remove posts. Ketac-Cem cement was also easier to manipulate (Mendoza and Stephen, 1994). Chapman *et al.* (1985) found that retention glass ionomer cement was equal to that of zinc phosphate, however glass ionomer cement also forms chemical bonds with tooth structure and it has greater compressive strength than zinc phosphate cements (Phillips, 1991). Haggs *et al.* (2002) in a study about the effect of 5 different cements on the retention strength of prefabricated endodontic dowels demonstrated that glasss ionomer cement (Ketac-Cem) had a retentive strength as much as 34.45 kg (Hagge *et al.*, 2002). These values are similar to our results.

CONCLUSIONS

Within the limitations of this study:

- There was no significant difference between the retentive values of the cast post when cemented with GC Fuji 1 or Ariamix cement.
- Cast post which subjected to tensile force 20 min after cementation had a minimum retentive value and those subjected to tension of Instron machine after 1 and 24 h had significantly more retentive values.

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