Evaluation the effect of three endodontic sealers on the retention of cast posts cemented with resin cement in vitro study

Etab N. Hussein BDS (1)
Abdul Karim Al-Azzawi BDS, MSc (2)

ABSTRACT

**Background:** Retention of the post is very important for successful restoration of endodontically treated teeth. The aim of this study was to evaluate the effect of three endodontic sealers on the retention of intraradicular posts cemented with resin cement.

**Materials and Methods:** Forty human maxillary canines were selected for this study. The crowns of the teeth were removed at the CEJ. The roots were embedded in acrylic blocks. After instrumentation, the roots were randomly divided into four groups (n=10) according to the tested sealer: G I: with no obturation (control), GII: gutta percha with ZOE sealer, GIII: gutta percha with Ca(OH)₂ sealer, GIV: gutta percha with resin sealer (AH26). The roots were stored for 72h in distilled water at 37°C and then prepared for 8mm depth and 1.8mm diameter with perso reamer to receive cast posts. After their fabrication, the posts were luted with a resin cement following the manufacturers instructions. The samples were stored for 72h at 37°C then the posts were removed from the roots using an Instron machine and tensile force was applied at a crosshead speed of 0.5 mm/min and load cell of 50Kg. The maximum force required for posts removal was recorded (N) the data submitted to statistical analysis by ANOVA, student t-test and LSD test.

**Results:** The results showed that the means of the groups respectively was: 209.3, 164.6, 197.4, 270. ANOVA test showed high significant difference between the control and other groups at the same time, the LSD test showed significant difference between GI and GII, GIII, while the difference between GII and GIV, GIII and GIV was high significant.

**Conclusion:** This study showed that the endodontic sealer has an influence on the adhesion of intraradicular posts with greatest negative effect for the eugenol based sealer.

**Key words:** Endodontic sealer, retention, cast post, resin cement.
The retention properties of the post in relation to the roots that will receive them depend on their characteristics, physio-chemical properties of the cement and the preparation of the root canal walls (1). Cementing is defined as the use of a moldable substance for sealing or cementing two parts, providing retention, filling spaces and reducing microleakage (4).

Zinc phosphate is still the luting agent most often employed, and it is the first choice for posts with adequate mechanical retention when fluoride release is not essential since it presents a long history of reliability and clinical success (5). Adhesive resin cements have been advocated for cementation of the post because they bond the post to tooth structure with greater strength than other cements. These agents achieve chemical adhesion as well as micromechanical bonding to dentin collagen and tubules, thus reduction of microleakage between the tooth and the restoration was a major advantage over non-bonding agent (6).

Resinous cements are technically difficult to manipulate than glass ionomer, zinc phosphate and zinc polycarboxylate. The cement may set prematurely as it has short working time thus preventing complete insertion of the post which could be disastrous in a clinical situation (6). The root canal sealers are used with the semisolid or solid core filling material to provide the required adhesion to canal walls, the cementation of the obturant materials to it, to fill voids and spaces between the obturant and the tooth structure and to form a fluid tight seal at the apex (7).

A great variety of endodontic sealers are available commercially, and they are divided into groups according to their chemical composition. They are based on zinc oxide and eugenol, epoxy resin, calcium hydroxide and glass ionomer (8). The sealers with the widest use today are the zinc oxide eugenol based materials, but these do not fulfil all of the ideal characteristics advocated for endodontic sealers (7).

Few studies have addressed the effects of endodontic sealers and their components on post retention has been reported substantial loss of retention when eugenol was used with resin-based cement because eugenol has deleterious effects on resin compounds (8,9,10).

**MATERIALS & METHODS**

Forty extracted human maxillary canines were selected according to the shape and length of the root. After extraction the teeth were stored in formalin until used. Before preparation all teeth were cleaned with hand scaler to remove surface soft tissue and calculus. A magnifying lens with the aid of light generated by light-cure unit was used to examine the teeth for the presence of cracks. The crowns of the teeth were removed at the level of cemento-enamel junction perpendicular to the long axis of the teeth using a water cooled diamond disk mounted in low speed handpiece, the pulp tissue was removed using barbed broach. The working length was determined by introducing a size 10 K-file into the canal until its tip just appeared at the apex; the working length was recorded as 1 mm shorter than that length. The root of the teeth were notched using diamond fisure bur in a high-speed handpiece equipped with distilled water spray to prevent dislodgement from the embedding material during testing procedure.

The roots were embedded in individual blocks of self-cured acrylic resin using a specially made square aluminium mold. A dental surveyor was used to position the long axis of the root parallel to that of the acrylic block to ensure loading along the long axis of the root when load was applied. The acrylic blocks were then kept in hermetic sealed containers with distilled water.

Root canals were instrumented to the working length up to size 50 K-file using crown down technique. Through out the instrumentation, irrigation with 2 ml of 2.5% of Na OCL was provided and a final rinse of 1 ml of 17% EDTA was used in order to remove the smear layer. Finally, root canals were flushed with distilled water and dried with paper points. Then the samples randomly divided into four groups according to the sealer used in the obturation: GI: with no obturation, GII: the roots filled with gutta percha and zinc oxide–eugenol sealer (Dorifill), GIII: filled with gutta percha and calcium hydroxide sealer (Apexit plus), GIV: filled with gutta percha and resin sealer (AH26). For the second, third and forth groups, the root canals were filled using lateral condensation techniques.

The sealers were mixed on a clean and dry glass slab with spatula according to the manufacturer’s instruction. By using file size 45, the sealer was carried into the canal and...
the file turned counter clockwise spinning the sealer into the canal. The master gutta percha point was coated with sealer and seated in the canal to the full working length. Canal obturation was completed with gutta percha auxiliary cones in conjunction with sealer. Excess coronal gutta percha was removed with a hot instrument and the canal entrance of all roots was sealed with a temporary material then stored in distilled water at 37 °C for 72 hours to allow setting of the sealers.

Gutta percha removal and cylindrical post space were done using perso drill No.6 for a length of 8mm measured from the coronal end of the root with the aid of a rubber stopper, post space preparation were done with a low–speed handpiece attached to a dental surveyor to obtain vertical preparation with standard diameter and dentin walls parallel to the long axis of the roots.

Post pattern were made directly on the prepared teeth using blue inlay wax and plastic posts. A 5mm long cylindrical post space was fabricated with the same diameter as that of the intracanal portion. A wax ring of with a diameter of 8 mm was fixed to the core for application of the force during the test. The patterns of the posts were cast in a nickel – chromium alloy according to the manufacturer’s instructions, after casting, any residual surface investment was removed by sandblasting, and any visible casting nodules also removed with a bur then the post were air abraded with 50µ aluminum oxide, then cleaned with water and dried. Each post fitted into it's respective canal to ensure proper seating of the cast post. A longitudinal groove was made in the side of the dowel to create a cement escape channel with round bur attached to high–speed handpiece. For all groups, cementation was done using self adhesive resin cement RelyX U100. The cement was mixed on paper mixing pad using plastic spatula according to manufacturer's instruction then the mixed cement was inserted in to prepared canal with lentulo spiral. A thin uniform cement layer was applied to the post surface and the post was seated into the post space, excess cement was removed immediately using disposable brush and apical pressure was applied to the post for 1 minute, and then leaves the post until setting occurred. Sticky wax was placed around the coronal end of the posts at the cement-tooth interface to exclude moisture effect during storage then the specimens were stored in distilled water at 37 °C for 72 hours then submitted to tensile bond strength testing.

The force required to dislodge the post was determined with a universal testing machine (Instron 1195), the embedded roots with it's acrylic resin block was clamped in the lower jaw of the Instron machine. The ring fixed to the core was grasped by the upper jaw of the machine, running at crosshead speed of 0.5mm/min. The maximum force required for post removal was recorded in (Newton) for each specimen and means were calculated and analyzed statistically by analysis of variance (ANVOA), student t-test and LSD test. After dislodgment, the posts were examined under stereomicroscope so the mode of failure could be evaluated.

RESULTS

The mean, standard deviation of the tensile force (in Newton) required to separate the posts in all groups are listed in Table 1.

Table 1: Mean and Standard deviation.

<table>
<thead>
<tr>
<th></th>
<th>GI</th>
<th>GII</th>
<th>GIII</th>
<th>GIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>209.3</td>
<td>164.6</td>
<td>197.4</td>
<td>270</td>
</tr>
<tr>
<td>SD±</td>
<td>39.424</td>
<td>41.46</td>
<td>26.771</td>
<td>42.013</td>
</tr>
</tbody>
</table>

The result of this study indicated that group IV showed the highest mean values (270 N) followed by group I (control, 209.3) then group III (197.4 N) while group II showed the lowest mean value (164.6 N).

One way analysis of variance (ANOVA) test was performed to test for any significant difference among the groups. The result showed high significant difference (p< 0.001) between the groups. Student t-test revealed a high significant difference between the control (without obturation) and other groups (P< 0.001).

The LSD test showed significant difference between group II and group III, while the difference between group II and group IV and the difference between group III and group IV was high significant.

The mode of failure indicated that 65% was adhesive failure, 22.5% was cohesive and 12.5% was mixed.

DISCUSSION

Beside the success of the root canal treatment, a successful final restoration is also mandatory for long–term clinical success. Extensive loss of tooth structure may require
post core restoration of a root canal filled tooth. However, in these systems the lack of adhesion permits apical or coronal microleakage that causes failure of root canal treatment. For this reason effective adhesion to intra-radicular dentin is a fundamental prerequisite to achieve the proper sealing of the endodontic space (11). Adhesive resin cements are being used for cementation of the post because of their stronger bond to tooth structure.

Three types of sealers have been used in this study, Dorifill sealer were modified zinc oxide-eugenol cements based on Grossman’s formulas and are by far the most popular and extensively used sealers. AH26 is an example of a resin- based sealer that has been used for many years despite the insolubility of the set material, making retreatment very difficult. The calcium hydroxide-based sealers (Apexit plus) were introduced in the 1980s, aiming to stimulate hard tissue formation for apical closure (12).

Although every effort has been made to select specimens of comparable characteristics and to standardize the procedures accurately, a wide range of standard deviations cannot be avoided. The variability of physical properties of human teeth may be one reason for the data spreads. Dentin is a heterogeneous tissue. Its structure, degree of calcification and degree of cellularity vary from tooth to tooth. Even though similar sized single-rooted teeth (maxillary canine) were used, there is considerable variation in modulus of elasticity of dentin and root canal morphology (13).

Clinically, post and core restorations are subjected to repeated tension, compression and torquing forces. Posts are probably dislodged when the cement fatigues and the bond to dentin is eventually lost .The bond between two materials is usually measured by applying tensile forces. Unfortunately, there is no practical method to simulate the oral conditions (13).

In this study, tensile force was applied to the posts to determine their retention and to compare the effect of different endodontic sealers on the adhesion of intraradicular post. The outcomes of the present study revealed that the force required for dislodgment of the posts in the control group was significantly higher (209.3 N) than that required for posts in group II (164.6 N) This is possibly due to the fact that the Dorifill contain eugenol (2-methoxy-4-allyphenol) which is a Phenolic compounds and capable of deactivation of molecules in the growing polymer chains . The eugenol release from these products can permeate dentin, adhered to the tooth structure. It would be impossible to get rid of all the eugenol molecules, and further interact with resin based restorative materials (14). Eugenol is a radical scavenger that inhibit the polymerization of resin materials, the negative chemical reaction involves the hydroxyle group of the eugenol that tends to protonize the free radicals formed during the polymerization of resin based materials, thereby blocking their reactivity and reducing the degree of the conversion of these materials (15).jeopardizing cement setting and compromising the bond between the tooth and the restoration would be assumed. Eventually such a restoration would fail because of lack of strength and /or increased solubility of incompletely polymerized resin cement (16).This result consistent with those of previous study by Hagge et al who investigated the effect of three root canal sealers on the retentive strength of endodontic posts luted with a resin cement and found significant difference between the control (with out obturation) and the group obturated with ZOE sealer (17).

The result of this study also coincide with Tjan and nemetz who investigated the retentive properties of Para-post cemented in the canals with resin cement in root canals contaminated with eugenol containing endodontic sealer. The retentive strength was found to be reduced significantly (18). Wimonchit et al also found in their study to evaluate the influence of eugenol contamination from root canal sealer on the retention of conventional cast and prefabricated post using resin cement that both posts was demonstrated that non-eugenol sealer had significantly greater retention than eugenol sealer (18).

The result of this study in line with Menezes et al who investigated the effect of Endofill (zinc oxide-eugenol sealer) on fibreglass bond strength to root dentin, Endofill was found to be associated with a significant reduction in bond strength values (19).

Al-Ali investigated the effect two eugenol–based sealers on the retention of prefabricated metal post luted with resin cement and found that both sealers significantly reduced the retention of prefabricated post luted with resin cement (20).
On the other hand, Schwartz et al found that the eugenol containing sealer had no effect on the post retention when cemented with resin cement (21), in addition the finding of this study is contrary to the finding reported by Al-Wazzan who found that dentin contamination with eugenol-containing temporary cement does not adversely affect the bond strength between resin cement and dentin to a statistically significant degree (14).

The etching with 37% phosphoric acid was found to be effective in restoring the retention that had been affected by eugenol (22). The use of 37% phosphoric acid as the etching agent of most the etch and rinse adhesion has only been reported to eliminates the contaminated smear layer and results into demineralization of dentin to a depth of 9-10µm. This depth of demineralization and the water rinsing after etching reduced the amount of sealers remnants on the dentin surface. Studies have demonstrated that the etch and rinse, three step adhesive system allow better and more effective bonding to the eugenol contamination dentin surfaces, compared to the self-etch approach due to the non-removal of the sealers debris entrapped within the smear layer (15).

Therefore, in daily clinical practice, when posts are placed after the used of eugenol based and other sealers, clinician should prefer the use of etch and rinse adhesion system. The cement used in this study is a self adhesive in which the self-etch bonding agent incorporated within the cement composition, so the sealer rich smear layer had been incorporated into the hybrid layer rather than remove it, this may explain the low force required to dislodge the post in group I and high force required in group IV (270 N) compared to control group due to the chemical composition of the AH26 sealer (Epoxy resin) this coincide with result of previous study done by Teixeira et al to evaluate the influence of endodontic sealers on the bond strength of carbon fiber posts they found that resin based sealer had statistically greater bond strength than other groups in which zinc oxide eugenol and calcium hydroxide sealer are used (23).

As the complete removal of calcium hydroxide from the root canal is almost impossible, residual particles might interfere with bonding in some area by acting as a physical barrier. In addition, due to it is high PH may also neutralize the self-etching primer solution of self-etch adhesive, significantly reduced it is etching effect and resulting in lower bond strength (15), which might explain the result of the present study. In group III in which calcium hydroxide was used, the force required were lower (197.4 N) than that of the control group, suggesting that the residues of calcium hydroxide left into the root canal space could have interfere with adhesion of intraradicular post.

The post analysis, after it’s removal from the canal space, evidenced that an adhesive failure mode was predominantly observed in all groups. These finding indicate that failure after testing mostly occurred at the interface between the luting agent and radicular dentin, and suggest that the values recorded provide a reliable estimate to the effect of endodontic sealers.

REFERENCES