Influence of eugenol and non-eugenol endodontic sealers on bonding fiber posts into root canal: a SEM investigation

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Summary
Influence of eugenol and non-eugenol endodontic sealers on bonding fiber posts into root canal: a SEM investigation.

Aim. The aim of this study was to evaluate the influence of eugenol and non-eugenol sealers on bonding fiber posts into root canal.

Methods. Forty-eight human maxillary incisors were endodontically treated and sealed with gutta-percha and eugenol and non-eugenol sealers. A week later the coronal part of the samples was removed and a fiber post was placed in each root. The posts were luted with the same dual adhesive resin cement and the core was built up. After a week, the root samples were longitudinally sectioned and prepared for SEM observation. The incidence of gaps found at the adhesive interface was recorded.

Results. There was no statistical difference regarding the presence of gaps at the adhesive interfaces among the groups of eugenol and non-eugenol sealers.

Conclusions. The use of both eugenol and non-eugenol endodontic sealers does not affect hybrid layer formation in a post luting procedure.

Key words: eugenol sealers, fiber posts, non-eugenol sealers, resin cements, scanning electron microscopy.

Sommario
Influenza di cementi endodontici contenenti eugenolo o privi di eugenolo sulla cementazione di perni in fibra di carbonio

Obiettivi. Lo scopo del presente lavoro è valutare l'influenza di cementi endodontici contenenti o non contenenti eugenolo sulla cementazione di perni in fibra di carbonio.

Metodi. 48 incisivi umani mascellari sono stati trattati endodonticamente e otturati con gutta-percha e cementi endodontici con e senza eugenolo. Una settimana dopo la parte coronale è stata rimosso e un perno in fibra è stato cementato all'interno del canale. I perni sono stati cementati con lo stesso cemento resinoso e il moncone è stato ricostruito. Dopo una settimana i provini sono stati sezionati longitudinalmente e preparati per l'osservazione al SEM. Si è quindi provveduto a misurare la presenza di gaps all'interfaccia adesiva.

Risultati. La presenza di gaps all'interfaccia adesiva tra i due gruppi di cementi endodontici non è risultata statisticamente significativa.

Conclusioni. L'uso di cementi endodontici contenenti o non contenenti eugenolo non influenza la formazione dello strato ibrido nel corso della cementazione di perni in fibra.

Parole chiave: cementi endodontici contenenti eugenolo, perni in fibra, cementi endodontici privi di eugenolo, cementi resinosi, microscopio elettronico a scansione.

Introduction

Posts are widely used to restore endodontically treated teeth with insufficient coronal structure to retain a core for a definitive restoration. Traditionally, posts have been cast or machined from metal, which could weaken root structure and eventually lead to fracture (Bateman, 2003). In the 1990s fiber-reinforced resinous matrix posts were introduced into clinical practice. These posts are fabricated from longitudinal glass fibers, embedded in a resin composite matrix. A wide variety of posts is available and includes parallel-sided, tapered, smooth and serrated forms. The primary advantage of a glass fiber post is its modulus of elasticity, which more closely approximates that of dentin (Mallmann, 2005). This elasticity may allow post flexion to mimic tooth flexion, so the post acts as a shock absorber, transmitting only a fraction of the stress placed upon the tooth to the dentinal walls. The low modulus of elasticity of fiber posts has been purported to reduce the risk of root fracture (Artopoulou, 2006).

Together with fiber posts, the use of adhesive systems for luting has increased in popularity and resin-cement materials have been proposed for use in combination with an acid-etching technique (Prisco, 2003). The bonding mechanism of adhesive systems to root dental walls is essentially micromechanical, based on hybridization of the demineralized surface and on resin tags and adhesive lateral branch formation (Sahafi, 2004). The infiltration of this network with resin permits formation of resin dentin interdiffusion zones. The effi-
cacy of a dentin bonding system can be evaluated by observing uniformity and quality of interdiffusion zones, resin tags and adhesive lateral branch formation and presence of voids or bubbles within the luting material or at the interface between it and the cavity walls and the post (Ferrari, 2001; Goracci, 2006). Many in vitro studies have investigated various factors that affect retention of a post. These factors include length, design, diameter and the surface treatment of the post (Balbosh, 2006). Clinical studies report that failures of fiber posts occur mainly at the cement-dentin interface, thus to improve the clinical success rate, the causes of the bond weakening should be investigated carefully (Ferrari, 2002; Goracci, 2005).

Dental materials commonly used in endodontics can affect the efficacy of adhesive luting systems and eventually lead to post decementation. Canal irrigation with both 5% NaOCl and RC Prep produced significantly large reductions in resin-dentin bond strengths (Morris, 2001). Eugenol containing root canal sealers are the gold standard of sealers in endodontics (Vano, 2006). The effect of eugenol and non-eugenol sealers on the retention of fiber posts is not yet fully understood. The presence of eugenol on the canal walls appears to have an adverse effect on post retention (Baldissarra, 2006; Ngoh, 2001). However, others report no difference between the use of a eugenol or non-eugenol sealer on post retention (Schwartz, 1998; Boone, 2001). The aim of the present study was to evaluate by SEM the quality and characteristics of the hybrid layer obtained in fiber post restorations when the root canal is obturated with different eugenol and non-eugenol sealers.

Materials and methods

Forty-eight human maxillary incisors selected for the study were placed in physiological solution immediately after extraction, where they were kept for the entire duration of the experiment. Only sound teeth with an average length of 23±1 mm were included in the sample (Monticelli, 2004). All canals were prepared by the same trained operator. The root canals were endodontically instrumented using stainless steel K-files (#08-10-15; Denstply-Maillefer, Konstanz, Germany) and rotary Ni-Ti instruments (Hero Shaper 20-25-30; Dentalica-MicroMega, Milan, Italy). The working length was obtained at 1 mm above the radiographic apex. All canals were prepared to ISO size 30, 0.06 taper. The root canal was irrigated at each change of instrument with 5.25% NaOCl (Niclor 5; Dental Ogna, Milan, Italy) and 17% EDTA (Dental Ogna, Italy). Alcohol was employed as the final rinse. The canals were dried with calibrated paper points and 4-5 coats of the adhesive system were applied to the canal walls with a micro-brush (Micerium, Italy). The adhesive system was prepared by mixing Ena Bond (Micerium) with Ena Bond cat (Micerium); this step allows the light-curing bonding resin to become auto-polymerizing. The root-canal was then gently dried. The bonding system was also applied onto the fiber posts and gently dried. Ena-Cem (Micerium, Italy) resin cement was mixed by its mixing brush (Micerium, Italy). The adhesive system was pre-}
adhesive interface: 0: no gaps; 1: gap no longer than 200 µm; 2: gap between 200 and 500 µm; 3: gap longer than 500 µm. Each section of the tooth was observed separately by two investigators. In the case of disagreement between the two investigators on the score assigned to a specimen, the worse score was chosen for the statistical analysis. The mean scores were statistically analyzed using the ANOVA to test for significance among the groups at 0.05 level of significance.

Results

The interfaces between the resin cement and the fiber post were essentially free of voids. SEM images showed good adhesion between post and cement (Fig. 1). More than 50% of samples showed voids/bubbles within the cement (Fig. 2). The cement thickness varied in relation to the root canal shape for each individual tooth. This parameter shows 100 micron differences at various levels of the sample; in the case of high cement thickness values (>150 microns), a significant presence of voids/bubbles was noted (Fig. 3). The results obtained regarding the adhesive interfaces are shown in Table I. The best adhesion was obtained at the coronal and middle third of the root. At the apical third, large irregularities/variations were detected (Fig. 4); the values recorded were statistically significant. There was no statistical difference regarding the presence of gaps at

Table I - Scores recorded (coronal third, medium third and apical third; 0: no gaps; 1: gap no longer than 200 µm; 2: gap between 200 and 500 µm; 3: gap longer than 500 µm) at the adhesive interfaces and mean values (groups with the same letter did not show any statistically significant difference).

<table>
<thead>
<tr>
<th>Sealer</th>
<th>Coronal third</th>
<th>Medium third</th>
<th>Apical third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endomethasone C</td>
<td>1.0 a</td>
<td>0.8 a</td>
<td>1.6 b</td>
</tr>
<tr>
<td>Argoseal</td>
<td>0.7 a</td>
<td>0.9 a</td>
<td>1.8 b</td>
</tr>
<tr>
<td>Bioseal Normal</td>
<td>1.0 a</td>
<td>1.1 a</td>
<td>1.9 b</td>
</tr>
<tr>
<td>Acroseal</td>
<td>1.0 a</td>
<td>0.9 a</td>
<td>1.7 b</td>
</tr>
<tr>
<td>AH plus</td>
<td>0.7 a</td>
<td>1.0 a</td>
<td>1.9 b</td>
</tr>
<tr>
<td>Sicura Seal</td>
<td>0.9 a</td>
<td>0.9 a</td>
<td>1.6 b</td>
</tr>
</tbody>
</table>
the adhesive interfaces among the groups of eugenol and non-eugenol sealers.

Discussion and conclusions

In the present study, the effect of eugenol and non-eugenol endodontic sealers on efficacy of post cementation was evaluated through SEM. Fiber post cementation is based upon the mechanisms of adhesive dentistry; several factors can affect this procedure, thus directly determining success or failure of fiber post restorations (Vichi, 2002). Escasslan Noirrit (2008) performed a morphological evaluation of fiber post/bonding system/root dentin interface by SEM; they didn’t reveal any artifact caused by the specimen preparation. Most studies in literature evaluated efficacy of post cementation through mechanical tests (de Durão Mauricio, 2007; Teixeira, 2008). The comparison of eugenol and non-eugenol sealers on the retention of posts cemented with resin cement has been studied with conflicting results. Boone (2001) and Kurtz (2003) reported no statistical difference in post retention when a eugenol and a non-eugenol sealer were used. Mannocci (1999) stated that the use of endodontic sealers and temporary filling materials containing ZOE had no detrimental effect on the marginal seal of carbon fiber post/composite resin core restorations. These results are in disagreement with the study of Bergeron (2001), which showed a significant increase in post retention in the case of a non-eugenol sealer. Eugenol sealers have setting times of up to several hours, allowing eugenol penetration into dentinal tubules (Schwartz, 1998). Tjan (1992) compared non-contaminated post spaces to post spaces contaminated with eugenol liquid. They reported a substantial loss of retention when eugenol was used with resin cement.

Vano (2006) investigated the effect on retention of immediate versus delayed cementation of fiber posts. They concluded that regardless of post system, immediate post space preparation and post cementation resulted in inferior post retention. Contamination of the post space with eugenol-containing sealer may impede setting of the luting resin cement during post cementation. Boone (2001) reported no difference between immediate and delayed cementation on post retention. Post space preparation technique significantly affects post luting procedures. All traces of gutta-percha and sealer are not always removed from the root canal wall, especially in areas of anatomical irregularities. The action of the drills used to remove the root filling material produces a smear layer with a high concentration of sealer and gutta-percha. Nevertheless, this procedure is essential in removing some of the contaminated dentin layer. This may explain why Schwartz (1998) concluded that the sealer type had no effect on post retention. Serafin (2004) reported highest fragments of smear layer at the apical third, where scarce or no presence of resin tags and lateral branches is always reported. The use of EDTA and NaOCl partially reduced the presence of smear layer and surface debris. In the present study, according to cited bibliography, a procedure for fiber post cementation was elaborated, in order to minimize the effect of eugenol sealers, and to mimic clinical conditions. A 1-week delayed cementation was chosen. Root canal preparation was performed through Gates drills, followed by calibrated drill. Smear layer was removed by EDTA followed by hypochlorite. These procedures can be considered effective, as eugenol and non-eugenol sealers did not affect the characteristics of the adhesive interface. The highest areas of bonding interface failure were recorded at the apical third; this was in accordance to many in vitro studies (Kurtz, 2003; Kalkan, 2006). Absence of voids/bubbles at the fiber post-resin cement interface could be a result of the strong bond between the resin matrix of the post and the resin cement; the presence of voids/bubbles within resin cement may be related to several factors, such as the luting procedures (mixing and placing the resin cement in the root canal space), the viscosity of resin cements, and the anatomy of the root (Ferrari, 2002). In fact, anatomical variations of roots and consequent variable thickness of resin cement could be another possible cause of void formation. Many factors concerning endodontic treatments and fiber post luting procedures need to be taken into consideration. However the results of the present study show that eugenol and non-eugenol endodontic sealers do not affect hybrid layer formation, when the correct luting procedure is followed.

References

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