Long Term Evaluation of the Sealing Ability of 2 Root Canal Sealers in Combination with Self-etching Bonding Agents

Introduction

Microleakage, whether from an apical or a coronal direction, is still a clinical problem and a possible cause of failure of endodontic therapy. Therefore, it is important for endodontic sealers to have a good sealing ability, for a long time. Microleakage studies on the sealing properties of endodontic materials have played an important role.

In recent years self-etching bonding systems are commonly used in restorative dentistry and also in the root canal sealing. Self-etching adhesive systems include primer, containing an acidic monomer, obviating the need for etch and rinse phases, which significantly reduces technique sensitivity or the risk of errors during application and manipulation. This is an important factor when used in root canals.

The use of self-etching bonding systems in combination with resin based sealers and gutta-percha has been the focus of many studies recently and the results are interesting.

An element of constituent in bonding between filler and root canal wall is the smear layer. Smear layer is formed on root canal walls as a result of endodontic instrumentation and acts as a barrier to the adaptation and penetration of root canal sealers into dentinal tubules. The self-etching materials have higher pH values than the acids used with “etch and rinse” adhesive systems, and the self-etching materials are not rinsed away, but remain in situ; as a result, the smear layer is incorporated within.
the bonding layers. There are still a number of questions about the effects of incorporated smear layer and residual hydroxyapatite crystals into the hybrid layer. In a previous study, the use of a self-etching system (Nanobond) improved the sealing ability of a resin based sealer (AH-26), but only after the removal of smear layer. The purpose of the present study was to compare the long term effects of self-etching adhesive system (Clearfil liner bond 2V) on the sealing ability of 2 endodontic sealers (AH-26 and Tulbiseal) in the presence of smear layer.

Materials and Methods

The materials used were AH-26 sealer (Dentsply, Konstanz, Switzerland), Tulbiseal (Sybronendo), Clearfil liner bond 2V (Kuraray medical INC, Japan) and gutta-percha cones (Spident, SPI Dental Mfg, Korea).

Microleakage Evaluation

90 single rooted human teeth used for this study had been extracted for periodontal and prosthetic reasons and subsequently stored in distilled water before use. The crowns were sectioned with high speed bar under water spray so that all roots were 14 to 15 mm long. A #20 K file was used in all teeth, 1 mm longer than root length, to assure apical patency.

The canals were prepared with the step-back technique (steps of 1 mm between different file sizes), using K and Hedstrom files (0.02 taper) (Dentsply Maillefer, Ballaigues, Switzerland). The working length was the same for all specimens (14 mm), and a #35 master apical file was used. NaOCl 5% was used as irrigant solution after the use of each instrument. Delivery of irrigant in the canal was performed with the use of a syringe equipped with a 27 Gauge needle. All the specimens were prepared to #55. Paper points were used to dry the root canals.

The teeth were randomly divided into 4 groups (20 teeth each), numbered from 1 to 4. 6 specimens were used as controls. In 3 teeth the external surface, including the apex, was covered with 2 layers of nail varnish (negative control). The other 3 specimens were filled by lateral compaction of gutta-percha, without sealer (positive control). 4 specimens only with bonding system were used for SEM evaluation. In all groups a final irrigation with 5 ml of distilled water was done. A #20 K-file was used to re-assure the apical patency and the root canals were dried with paper points. After 30 sec, Bond liquids A and B were mixed and applied into root canals with a micro-brush. Any excess was removed with paper points.

Teeth in groups 1 and 2 were filled with AH-26 sealer in combination with gutta-percha cones. Teeth in groups 3 and 4 were filled with Tulbiseal sealer in combination with gutta-percha cones. Sealing with any sealer (AH-26, Tulbiseal) and gutta-percha cones was performed by the same operator as follows. The master cone, corresponding to the master apical file (#35), was inserted into root canals (at 14 mm) coated with sealer. Lateral compaction was performed with the successive use of finger spreaders sizes 25 and 20. Standardized cones (#20) were used as accessory points. Sealing was considered complete when it was not possible to place an accessory cone further than 2 mm into root canal. Excess gutta-percha was removed with a heated instrument at the canal orifice and final vertical compaction was completed with a finger plugger. Excess sealer was removed with a cotton pellet. After sealing, all specimens, except for the 2 apical mm and the flat coronal surface, were coated with nail varnish.

Microleakage was evaluated by fluid transport model as described by Wu et al. The root sections were connected to a plastic tube on either side of the specimen and kept in distilled water at 37°C for 7 days. A standard glass capillary tube was connected to the plastic tube on the outlet side of the specimen. Using a syringe, water was retracted approximately 3 mm into the open end of the glass capillary. The whole set-up was then placed in a water bath (20°C) and, using a syringe, the air bubble was adjusted to a suitable position within the capillary. A pressure of 0.2 Atm was applied from the inlet side to force the water through the voids along the filling, thus displacing the air bubble in the capillary tube. The volume of the fluid transport was measured by visual inspection of the air bubble position by the same observer. The displacement of the air bubble was recorded as the fluid transport results (L), expressed in μL/24h.

Microleakage was measured at 7 days, 1 month and 1 year. Between measurements, the specimens were kept in distilled water at 37°C. The results were analyzed by nonparametric tests (Kruskal-Wallis and Mann-Whitney tests).

SEM Evaluation

The bonding system was placed in 4 specimens, those that were then prepared to be examined by scanning electron microscope (SEM). After 7 days storage in distilled water, cross sections of bonded interface were prepared using a microtome. The sections were polished with 1200 grit SiC papers under copious water irrigation, then exposed to 6 mol/L HCl for 30 sec and 1% NaOCl for 10 min. After carbon sputtering, the specimens were examined by SEM (JSM 840 A; JEOL Co., Tokyo, Japan).
Results

Microleakage

In the case of the positive controls, the air bubbles moved rapidly along the tube as soon as pressure was applied. No movement of the air bubble in the capillary tubes was observed in the negative controls. The microleakage in root sections was measured, as mentioned before, at 7 days, 1 month and 1 year, and the results expressed in μl/24h.

Short term results: at 7 days and 1 month, no statistically significant differences were found between experimental groups (Tabs. 1 and 2).

Long term results: at 1 year, the group 1 (Kuraray, AH-26) leaked significantly less than groups of Tubiseal. No other significant differences were found between experimental groups (Tab. 3).

| Table 1. Results of measurement after 1 week (L=μl/24h) |
| L=0 | 0<L≤10 | 10<L≤20 | L>20 |
| Group 1 | 5 | 2 | 1 | 12 |
| Group 2 | 0 | 4 | 2 | 14 |
| Group 3 | 4 | 1 | 0 | 15 |
| Group 4 | 3 | 0 | 1 | 16 |

| Table 2. Results of measurement after 1 month (L=μl/24h) |
| L=0 | 0<L≤10 | 10<L≤20 | L>20 |
| Group 1 | 5 | 1 | 1 | 13 |
| Group 2 | 0 | 3 | 3 | 14 |
| Group 3 | 4 | 0 | 1 | 15 |
| Group 4 | 2 | 1 | 1 | 16 |

| Table 3. Results of measurement after 1 year (L=μl/24h) |
| L=0 | 0<L≤10 | 10<L≤20 | L>20 |
| Group 1 | 2 | 1 | 0 | 17 |
| Group 2 | 0 | 0 | 3 | 17 |
| Group 3 | 0 | 1 | 0 | 19 |
| Group 4 | 0 | 0 | 0 | 20 |

SEM

Scanning electron microscopy evaluation showed the bonding system in close contact with dentin and the formation of hybrid layer (Fig. 1).

Discussion

Several methods have been used to investigate the microleakage of root canal sealers. The fluid transport model, proposed by Wu et al7, offers several advantages over more commonly used techniques for microleakage assessment. It has been suggested that the fluid transport model is both highly reproducible and more sensitive than dye penetration for detection of full length voids along the root canal9. This method does not destroy the specimens, which means that it is possible to assess microleakage at different time intervals over extended periods using the same specimen. Leakage should be assessed not only immediately after sealing but also over time because sealing needs to be long lasting to be clinically effective. However, the method requires careful manipulation in connection with plastic tubes and glass capillaries to avoid erroneous measurements.
Combinations of bonding agents and sealers have been proposed for endodontic sealing. Many studies have evaluated the effectiveness of these restorative root canal systems with contradictory results13,4,10-12.

The achievement of bond between adhesive systems and dentine depends on penetration of monomers into the conditioned dentine surface to create micromechanical interlocking between the dentin collagen and resin and thus to form a hybrid layer4,14. Root dentin is a difficult substrate to bond. Many investigators have studied the structure of radicular dentin and found differences from coronal dentin14,15. Accessory root canals, resorption, the lower number of dentinal tubules, irregular secondary dentin and the high configuration factor of root canal are problems for effective application of adhesive materials.

Besides the unfavorable geometry, there are other factors that affect bonding to root canal, such as application of primer deep into root canal, the surplus of the primer and adhesive solvent that remains within the bonding structure, partly the degradation of hybrid layer done by enzymes released by bacteria and by dentin itself15,16. Another problem involves the thick smear layer generated in root canal instrumentation because it is difficult for mild acidic self-etching bonding agents to dissolve and incorporate it into the bonding process. Smear layer removal has been the focus of several studies aimed at optimizing chemo-mechanical preparation of the root canal system and seems to reduce microbial flora and enhance the sealing properties of root canal filling materials17.

The results of the present study suggest that the use of self-etching adhesive systems in combination with endodontic sealers in the presence of smear layer does not have a statistically significant effect on the sealing ability of the sealers used in all examined periods. The sealers used in the present study were a commonly used resin based sealer (AH-26) and Tubliseal - a eugenol-based sealer that contains 14% of oleo resin. On the other hand, a recent study6, examined the microleakage of AH-26 sealer in combination with a self-etching bonding system (Nanobond) with and without pretreatment with EDTA solution 15%. They found that the sealing ability of resin based sealer was improved with the use of bonding system when smear layer was removed. The removal of smear layer facilitates better infiltration of resin and sealer into dentinal tubules and a better seal. These findings are in agreement with those of Mannocci and Ferrari4.

Self-etching adhesive systems with high pH values dissolve smear layer and partially demineralise the underlying dentin surface2. Since self-etching materials are not rinsed away but remain in situ, smear layer components are incorporated within bonding layers. The use of bonding agents into root canals will be the focus of research in the future.

Conclusions

The sealing ability of AH-26 and Tubliseal sealers was not significantly improved if a self-etching bonding agent was used in the presence of smear layer.

At 1 year measurements, leakage was significantly less in the group with Kuraray and AH-26 than in groups with Tubliseal.

References


Correspondence and requests for offprints to:

Nikos Economides
Aristotle University of Thessaloniki
Faculty of Dentistry
Department of Endodontology
Thessaloniki, Greece
e-mail: econom@dent.auth.gr