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Effect of Smear Layer Removal on Bond Strength of Two Different Resin-Based Sealers; an In Vitro Study

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Abstract

Statement of Problem: During root canal preparation, organic pulpal materials, bacteria and blood cells in combination with inorganic dentinal debris accumulate on the canal wall, producing an amorphous irregular smear layer. The effect of smear layer on the bond strength of endodontic sealers is controversial.

Objective: The aim of this *in vitro* study was to evaluate the bond strength of two resin-based root canal sealers to dentin, with or without the presence of smear layer.

Materials and Methods: The root canal of Sixty human single rooted teeth were prepared and irrigated by saline, NaOCl, or NaOCl+EDTA. In each group, the root canals were obturated using AH Plus or EndoRez sealers. After 7 days, two horizontal slices of approximately 1.5mm thickness were obtained from the middle third of each root and the push-out bond strength of root canal fillings was assessed using the universal testing machine. Data were analysed using two-way ANOVA and Tukey tests. The significance level was set at p <0.05.

Results: Regardless of sealer type**,** the highest bond strength was observed in group 2 (NaOCl) which was significantly different from those of group 3 (NaOCl+ EDTA) (p =0.003). Regardless of irrigation protocol, AH Plus showed higher bond strength compared to EndoRez (p =0.001).

Conclusion: Within the limitations of this study, it was concluded that the experimental sealers bonded better to dentine in presence of smear layer.

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Introduction

To obtain bacteria-free root canals there is always a need for chemo-mechanical debridement [1]. However, during this procedure, organic pulpal materials, bacteria and blood cells in combination with inorganic dentinal debris accumulate on the canal wall, producing an amorphous irregular smear layer [2-4] This layer has a thickness of 1 to 5μm and also can be packed into the dentinal tubules to various distances [3, 5].

There is no consensus on removing the smear layer before obturation. Some authors believe that smear layer covers prepared areas and prevents medicaments and filling materials from penetrating the dentinal tubules or even contacting the canal walls [1, 3, 6-7]. Others, state that the smear layer can actually form a physical barrier and may be responsible for decreasing bacterial penetration into tubules [8].

The effect of smear layer removal on the bond strength of sealer cements to dentin has been the subject of several studies.In some studies, increasing in the bond strength of sealerswas reported when smear layer was removed [1, 9-10]. However, others showed no significant difference or even higher bond strength when the smear layer was present [11-14].

Given to the controversy regarding the effect of smear layer removal on the bond strength of resin-based sealers, the aim of this *in vitro* study was to evaluate the bond strength of two resin-based root canal sealers to dentin, with or without the presence of smear layer.

Materials and Methods

Sixty human single-rooted teeth extracted for periodontal or orthodontic reasons were selected and stored in 0.9% NaOCl containing 0.02% Sodium Azide at 4°C to prevent bacterial growth. Teeth were examined macroscopically and radiographically for having a straight fully formed root with a single canal without calcifications, cracks or resorptions.

The crowns were removed and the working length was determined at 1mm short of the apical foramen.The root canals were prepared by electric motor (EndomotorEndomate DT, NSK, Japan) using ProTaper rotary files (Dentsply, Maillefer, Switzerland) in the following sequence: S1, S2, F1, F2, and F3.

The samples were randomly divided into 3 groups (n=20) based on the irrigation protocol.

In group 1, the root canals were irrigated between each file with 2 mL saline. In group 2, the irrigation protocol consisted of 2 mL 5.25% NaOCl (CERKAMED, Poland) between each file. In group 3, the root canals were irrigated between each file with 2 mL 5.25% NaOCl and at the completion of instrumentation 5 ml 17% EDTA (CERKAMED, Poland) was used for 1 minute.

Five mL of distilled water (DW) was used after each solution to avoid interactions [15] and 10mL of DW was used as a final flush in all groups.

After root canal preparation, the samples in each group were divided into two subgroups (n= 10) based on the sealers used for obturation. After drying the root canals with paper point (GAPADENT, Germany) sealers had been introduced into the root canal orifices with the intraoral tips.In one subgroup the root canals were filled with gutta-percha (GAPADENT, Germany) cones and AH Plus sealer (DentsplyDeTrey, Kontanz, Germany) using cold lateral compaction. In the other subgroup, the canals were similarly obturated using EndoRez sealer (Ultradent, South Jordan, Utah). Mesiodistal and buccolingual radiographs were taken to assess the quality of obturation. The specimens were then stored at 95% relative humidity and 37°C for 7 days.

Push-out assessment

Two horizontal slices of approximately 1.5 mm thickness were obtained from the middle third of each root by using a slow-speed, water-cooled diamond saw machine (Presi SA, Angonnes, France).

The specimens were examined under a light microscope (Best Scope-3060c, China) to confirm a circular canal shape. Finally, 16 slices per subgroups were selected. The thicknesses of the root slices were measured using a digital calliper (Mitutoyo, Japan). Afterwards, apical and coronal aspects of each slice were photographed under a light microscope connected to a digital camera (Best Scope, China). The diameters of the coronal and apical aspects of the filling materials were measured using ScopeImage 9.0 software.

The filling material was loaded in an apical-coron-

al direction with a cylindrical stainless steel plunger 0.7 mm in diameter. Loading was performed in a universal testing machine (Zwick/Roell, Z050; Zwick/ Roell, Ulm, Germany) at a speed of 0.5mm/ min until bond failure occurred.

The maximum load applied to filling material before deboning occurred was recorded in Newtons. To express the bond strength in mega Pascals (MPs), the maximum load in Newtons was divided by the adhesion area (mm2). The adhesion area of each slice was calculated using the following formula:

$\pi(R+r)[(R-r)^2+h^2]^{1/2}$

Whereπ=3.14, R is the coronal radius, r is the apical radius, and h represents the thickness of the slice.

Data were analysed using two-way ANOVA to evaluate the significance of differences (interaction effect) between sealer types and irrigation protocols. The post hoc Tukey test was used for pair-wise comparison of the groups. The level of statistical significance was set at 0.05.

Result

The mean and Std.Deviation of bond strength (mega Pascal) are summarised in Table 1.

Table 1: The mean and Std.Deviation of bond strength (mega Pascal)

Irrigation Protocols	AH Plus Mean(±SD)	EndoRez Mean(±SD)
G1: Normal saline(NS)	1.94(±0.55)	0.68(±0.3)
G2:NaOCl	2.61(±1.14)	0.80(±0.22)
G3:NaOCl+ EDTA	1.84(±0.94)	0.59(±0.26)

No interaction effect was found between irrigation protocol and sealer type (p =0.375). Regardless of sealer type, there was a statistically significant difference between different irrigation protocols (p =0.006).

The highest bond strength was observed in the group #2 (NaOCl group) which was significantly different from those of group #3 (NaOCl+EDTA) (p =0.003). Regardless of irrigation protocol, AH Plus showed significantly higher bond strength compared to EndoRez (p= 0.001).

Discussion

Adhesion of sealers to the root canal dentin is one of the most important characteristic of endodontic sealers for two reasons including the superior seal which in turn results in less leakage [16], and prevention of displacement of the filling material during restorative procedures [17].

Different methods including microtensile, shear bond, pull-out and push-out tests have been used for assessing the bond strength of dental materials to dentin [18].

Among these methods, microtensile and push-out tests can be used to evaluate the bond strength in different parts of the root canal. However, preparing the samples for microtensile test is very difficult and they may fracture before the test. On the other hand, the pushout test is easy to perform without limitations of microtensile test with accurate and reliable results [19].

In this study the effect of the removal or the presence of smear layer on the bond strength of two different resin based sealers was evaluated. Our results showed removal of smear layer had a negative effect on the bond strength regardless of sealer type. Similar findings have previously been reported. Saleh *et al.* [20] who evaluated the effect of various dentin pretreatments on the adhesion of different sealers concluded that removal of smear layer might impair sealer adhesion to dentin. Similarly, Lalh *et al.* [11] showed that the bond of glass ionomer cement sealers was better with the smear layer present.

One possible explanation is that application of EDTA may cause a collapse of the dentin matrix structure, which impedes sealer infiltration, and the formation of high quality hybrid layer bonding [21].

On the other hand, in some studies, smear layer removal has been shown to increase the bond strengths of sealer cements to dentin [9-10]. The increased bond strength has been attributed to the creating much more irregular surface and also to the increased penetration of sealer into dentinal tubules after smear layer removal [6, 9].

These controversial results might be attributed to the different smear layer removing protocol [2, 22-24] and different techniques used for evaluating bond strength [19]. Moreover, the mechanism of bonding amongst the wide range of sealers with different chemical compositions can be expected to be different. Therefore, Different sealer types may require diff-

erent dentine pre-treatments for optimal adhesion [20].

In the present study, two resin based sealers were used; one epoxy-amine resin- based sealer (AH Plus) and one methacrylate resin-based sealer (EndoRez). Based on the results of the present study, regardless of irrigation protocol, AH Plus showed significantly higher bond strength compared to EndoRez.

This finding is in accordance with the results of some previous studies [25-26]. The higher bond strength of AH Plus can be explained by the fact that this sealer penetrated more into dentinal tubules than did EndoRez. Another explanation may be the lower volumetric shrinkage of AH Plus during polymerization compared with methacrylate resin-based sealers [27-28].

Conclusion

Under the condition of this *in vitro* study, smear layer removal is not recommended before application of resin-based sealers.

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Conflict of Interest: None declared.

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