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Original Article

A Comparison of Push-Out Bond Strength of Two Endodontic Sealers to Root Canal Dentin: An in Vitro Study

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Abstract

Statement of Problem: Adhesion to root canal dentin is one of the necessary characteristics of endodontic sealers. MTA Fillapex (Angelus, Londria, PR, Brazil) is one of the recently introduced MTA-based sealer. Only a limited number of studies have evaluated the bonding of this sealer to the dentin, with conflicting results.

Objectives: The purpose of this study was to evaluate the bond strength of MTA Fillapex sealer) to root canal dentin compared to an epoxy resin-based sealer (AH26 sealer).

Materials and Methods: Twenty root blocks (6mm length) were acquired from the middle part of the extracted single-rooted central or lateral maxillary incisor roots and their lumens were enlarged to achieve a diameter of 1.3 mm. MTA Fillapex and AH26 were placed in the lumens of root blocks (n = 10). The specimens were kept in an incubator for 7 days, the roots were sectioned perpendicular to their long axis to achieve slices with thickness of 1 mm and the push-out test was carried out by a universal testing machine.

Results: The mean value of bond strength was 1.84 ± 0.7 Mpa for AH26 and 0.19 ± 0.1 Mpa for MTA Fillapex. The difference between the two groups was statistically significant ($p < 0.001$).

Conclusions: With in the limitation of this study, AH 26 showed significantly higher bond strength in comparison to MTA Fillapex.

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Introduction

Apical periodontitis is predominantly caused by microorganisms and their by-products [1]. Successful endodontic treatment depends on the complete debridement of the root canal system, elimination of pathogenic microorganisms, and complete filling of the canal space to prevent ingress of the bacteria from the oral environment and its spread to the periradicular tissues [2]. The physical properties for achieving a complete sealing include adaptation and adhesion of the filling material to the root canal wall [3]. The use of a root canal sealer with a core filling material is considered as a standard procedure in endodontic obturation. Because gutta percha, as the core material, does not directly bond to the dentin surface, the sealer should be capable of filling the gaps between gutta percah cones and also present bond strength to root dentin [3,4]. It has been suggested that the ability of the root canal sealers to adhere to the core material and to the dentin may result in better sealing ability and reduction of the coronal and apical leakage [5].

Several types of sealer have been used in endodontics, including those based on zinc oxide eugenol, glass-ionomer cement, calcium hydroxide and a range of resins. However, the absence of an ideal endodontic sealer has encouraged the development of new materials.

Mineral trioxide aggregate (MTA) is a material consisting of tricalcium oxide, tricalcium silicate and silicate oxide [6]. Biocompatibility, low toxicity, low microleakage, antimicrobial properties and its ability to set in the presence of moisture or blood are among the advantages of this material [7]. Because of these properties, MTA has been used for several clinical applications such as root repair material, root-end filling, and pulp capping [8]. However, because of its working time, setting time, and difficult handling, MTA does not exhibit the physical characteristics needed to be used as an endodontic sealer [9].

In order to use this material as endodontic sealers, the original formulation has been modified to improve the characteristics such as setting time, flow and adhesion [10-12]. MTA Fillapex (Angelus, Londria, PR, Brazil) is one of the recently introduced MTA-based sealers which is presented in a paste/paste system. Its composition after mixing is basically MTA, salicylate resin, natural resin, bismuth oxide, and silica. It has been shown that this sealer has acceptable physicochemical properties, such as good radiopacity, flow, and alkaline pH [7]. Another study showed that MTA Fillapex has a suitable flow, working and setting times, solubility and water sorption [13].

Only a limited number of studies have evaluated the bonding of this sealer to the dentin, with conflicting results. Two studies have shown that MTA Fillapex sealer has a lower bond strength to the root dentin compared to the epoxy resin –based sealer AH Plus (Dentsply-De Trey, Konstanz, Germany) [14,15]. On the other hand, on the basis of another study, MTA Fillapex presented acceptable resistance to dislodgment, which was similar to that of AH Plus sealer [16].

Therefore, the aim of the present study was to evaluate the push out bond strength of MTA Fillapex to root canal dentin compared with the epoxy resin-based sealer AH 26 (Dentsply-De Trey, Konstanz, Germany).

Materials and Methods

Twenty extracted human maxillary incisors with similar morphologies were selected for this study. All the teeth had mature apices and intact roots, and no cracks were seen on them under light electron microscope. Very long or very short teeth, curved roots, and teeth with any sign of internal root resorption, calcification or previous endodontic treatment were excluded from the study. Apical and coronal parts of the roots were sectioned so that root blocks with 6 mm in length were obtained. In order to standardize the internal diameter of all root blocks, the lumens were instrumented with Gates Glidden burs (Many, Tochigi, Japan), size 2 to 5, to achieve a standardized diameter of 1.3 mm. In order to remove the smear layer, the sections were immersed in 5.25% sodium hypocholorite (Glorang, Iran) followed by 17%EDTA (Ariadent Tehran, Iran), each for five minutes. The samples were then immediately washed with distilled water and dried. The apical ends of all blocks were sealed with waxed resin. Root blocks were then randomly allocated in two groups (n = 10) and the root canal sealers were filled: Group I, MTA Fillapex (Angelus, Londria, PR, Brazil); and Group II, AH 26 (Dentsply-De Trey, Konstanz, Germany). All specimens were filled with the sealers without

core material. The sealers were prepared according to the manufacturer's instructions and introduced into the root canals using a lentulo spiral (Sevenska Dentorama, Solna, Sweden) ≠ 40. The specimens were stored in an incubator at 37º C and 100% humidity in the vertical position. After 7 days, all the root blocks were sectioned transversally into 1 ± 0.2 mm thick slices. The slices were then examined under a light microscope (dine –lite Taiwan) at ×20 magnification for the roundness of the lumens and presence of any voids in the samples (Figure 1). Slices with any observable voids in the sealer mass or in the sealer dentin interface were excluded from the study. Finally, 20 slices for each sealer were obtained from the dentin blocks.

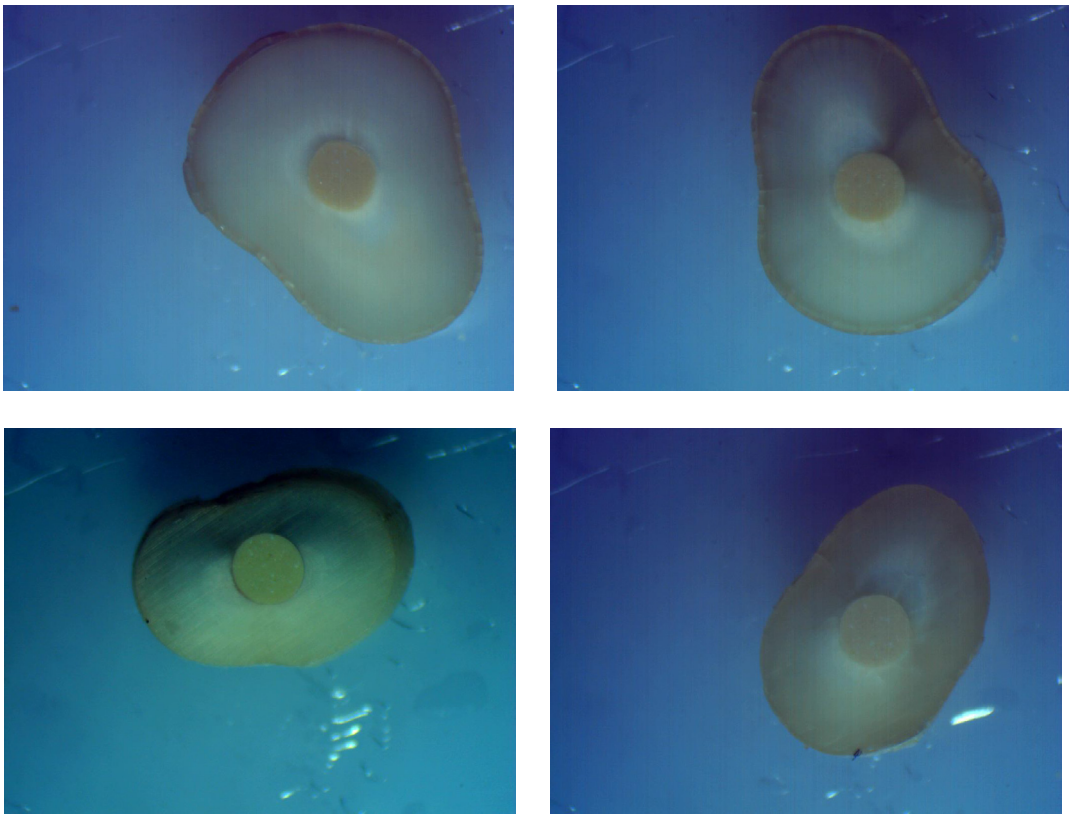

Figure 1: Some root slices selected for push-out test

The samples were subjected to Push-Out bond strength test by using a universal testing machine (Zo20; Zwick/Roell/ Germany). The samples were placed on a metal slab with a central hole to allow the free motion of the plunger. The compressive load was applied by exerting a downward pressure on the surface of the materials using a 0.7 mm diameter cylindrical stainless steel plunger at a speed of 1 mm/ min. The maximum load applied to the materials was recorded in newtons (N) at the time of dislodgment by a computer. In order to express the bond strength in Mpa, the following formula was used: Mpa = N/2πrh, where N = the maximum load for each specimen, r = root canal radius in mm, h = the thickness of the root dentin slice in millimeters, and π = 3.14.

The values of the bond strength were analyzed using independent T-test. Statistical analysis was performed by using SPSS software version 17 for windows (SPSS Inc, Chicago, IL) and the significant level was set at .001.

Results

The mean push out bond strength for AH26 was 1.84 ± 0.7 Mpa whereas it was 0.19 ± 0.1Mpa for MTA Fillapex. AH26 sealer showed a statistically significant higher bond strength compared with MTA Fillapex ($p < 0.001$).

Discussion

Adhesion to the root canal dentin is one of the necessary characteristics of endodontic sealers for

two reasons: the superior seal which in turn results in less leakage [5], and prevention of the dislodgment of the filling material during restorative procedures [17].

Different methods including microtensile, shear-bond strength, pull-out and push-out tests have been used to evaluate the bond strength [18]. Among these methods, microtensile and push-out tests are able 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 push-out test does not have the limitation of microtensile test; therefore, the results are more accurate and reliable [19].

In some studies that have investigated the bond between sealers and the canal wall, the samples have been filled with a sealer in association with a core material [4,14,16] while in some studies the canals were filled only with sealer [4,20]. When canals are filled with sealer and core material, the sealer is generally present as a thin layer, with two interfaces: between the dentin and sealer and between the sealer and the main cone. On the other hand, when the canal is filled only with sealer, like the present study, only one interface (sealer and dentin) is present, making it possible to only evaluate the bond strength between the sealer and dentin [4]. Moreover, the absence of a core material allows the root canal sealer to achieve its full expansion without being affected by the weak interface between the sealer and core material.

In this study, all root blocks were prepared with the same 1.3 mm-diameter gates glidden drill, making sure to avoid the influence of anatomical variation over the results.

As the presence of smear layer may affect the bond strength of the materials to root canal dentin, in the present study the smear layer was removed from all samples before the application of sealers. Based on the majority of studies, irrespective of the type of the sealer, the bond strength to dentin is decreased in the presence of the smear layer [21-23].

The results of the present study showed that AH 26 sealer had significantly higher bond strength to dentin, compared with MTA Fillapex. This result is in agreement with the results of the study conducted by Sagsen *et al*. [14] and Amin *et al*. [15]. Previous studies have explained the higher bond strength obtained with the epoxy resin–based sealers by the ability to form a covalent bond by an open epoxide ring to any exposed amino groups in collagen, long-term dimensional stability, and low polymerization stress [24-26].

MTA is one of the ingredients of MTA Fillapex, and it has been suggested that the release of calcium and hydroxyl ions from the set MTA will result in the formation of apatites as the material comes into contact with phosphate-containing fluids [27]. Reyes-Carmona *et al*. reported that the apatite formed by MTAis deposited within collagen fibrils, promoting controlled mineral nucleation on the dentin, seen as the formation of tag-like structures [28]. The reason for the low bond strength of MTA Fillapex to the dentin has been attributed to low adhesion capacity of these tag-like structures.

Conclusions

On the basis of the findings of this study, AH 26 had higher bond strength to dentin in comparison to MTA Fillapex.

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