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Shear Bond Strength of Different Root Canal Sealers To WMTA and Biodentine

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Research Article

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ABSTRACT

The aim of this study was to evaluate the shear bond strength of the AH Plus, Tubli-Seal, MTA Fillapex, and Sealapex root canal sealers when used with WMTA (White Mineral Trioxide Aggregate) and Biodentine. WMTA and Biodentine were prepared and placed into central holes of cylindrical acrylic blocks. The blocks were stored at 37 °C and 100% humidity for 96 hours for the cements to set. The samples were then divided into 4 subgroups of 10 blocks each to be tested with the four root canal sealers, Sealapex, AH Plus, MTA Fillapex, and Tubli-Seal. The sealers in cylindrical plastic tubes were placed in the center of the WMTA and Biodentine surface. After the setting process, the samples were stored at 37 °C and 100% humidity for 48 hours The chisel edge of a stainless steel plunger was inserted into the cement/sealer interface to measure the shear bond strength (SBS) and the data were statistically evaluated by One-way analysis and post hoc Turkey tests ($p<0.05$). The highest and lowest bond strength values were recorded for AH Plus and Tubli-Seal to Biodentine, respectively. Tubli-Seal and MTA Fillapex demonstrated similar SBS values. Sealapex showed significantly higher bond strength than Tubli-Seal and MTA Fillapex. No significant differences were found between WMTA and Biodentine in all root canal sealer groups. MTA and Biodentine demonstrated similar shear bond scores with all root canal sealers. AH Plus had the highest bonding values to MTA and Biodentine when compared with the other sealers

INTRODUCTION

A number of root-repair materials have been developed by various manufacturers, including Mineral Trioxide Aggregate (MTA) that has adequate biological and physical properties of a good root repair material [1,2]. MTA has been used for apexification, perforation repair, root resorption, and as a root-end filling material. The main ingredients of MTA are silicate oxide, tricalcium oxide, tricalcium aluminate, and tricalcium silicate [3,4].

Despite many advantages of MTA, researchers have searched for alternative materials because of its prolonged setting time and high price [5]. Different calcium silicate-based cement, including like Biodentine, have been introduced as alternatives to MTA [1]. Biodentine has recently been developed as a dentin replacement and also introduced as a pulp capping and endodontic repair material. It is very similar in its composition to MTA, except that zirconium oxide is added as a radiopacifier to Biodentine [6]. It sets, however, in 10 to 12 min, which is a much shorter time than that of MTA and Bioaggregate. Biodentine is sold as a powder packaged in capsules (0.7 g) to be mixed with a liquid phase (0.18 mL) containing calcium chloride [7].

Adhesion is clinically very important for the success of root canal treatment. A desired property of ideal root canal filling material is the ability to bind effectively to surrounding surfaces such as the root dentin walls and other filling materials [8].

After apexification, perforation repair, root resorption, and also apical surgery treatment of teeth, root repair materials, such as MTA or Biodentine, are used with other sealing materials, such as root canal sealers and gutta-percha. Consequently, the interface bonding between root repair materials and root canal filling materials may be as important as the interface bonding between root repair materials and dentin. Several studies have evaluated the adhesive effectiveness of restorations placed over MTA or Biodentine [9-13]. However, there is no published data on the bond strength of different root canal sealers to MTA or Biodentine. The aim of this *in vitro* study was to evaluate the SBS of the AH Plus, Tubli-Seal, MTA Fillapex, and Sealapex root canal sealers when used with MTA and Biodentine.

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MATERIALS AND METHODS

White MTA and Biodentine were used in this study with the AH Plus, Tubli-Seal, MTA Fillapex and Sealapex sealers. The compositions and powder-to-liquid ratios of the materials are listed in **Table 1**.

Table 1. Composition of the endodontic sealers, as provided by the manufacturer WMTA (White Mineral Trioxide Aggregate).

Material	Manufacturers	Composition	Methods for Application
Biodentine®	Septodont, Saint Maur, des Fosses, France	Tricalcium silicate, calcium carbonate ,and zirconium oxide, a liquid part containing calcium chloride	Mixing in an amalgamator for 30 s
WMTA	Angelus,Londrina, PR, Brazil	Tricalcium silicate, bismuth oxide, dicalcium silicate, tricalcium aluminate, calcium sulfate dehydrate or gypsum	Mixing powder and liquid in a 1:3 ratio
Sealapex	Sybron Endo, Glendora, CA, USA	Calcium hydroxide based root canal sealer	Base and Catalyst were mixed in equal amounts
		Base: calcium oxide, zinc oxide	
		Catalyst: disalicylate resin, trisalicylate resin, isobutyl salicylate	
AH plus	Dentsply, Konstanz, Germany	Epoxy resin-based sealer	Past A and Past B were mixed in equal amounts
		Paste A: bisphenol-A epoxy resin,bisphenol-F epoxy resin, calcium tungstate, zirconium oxide, silica, iron oxide pigments	
		Paste B: dibenzyldiamine, aminoadamantane, tricyclodecanediamine, zirconium oxide, silica, silicone oil	
MTA Fillapex	Angelus, Londrina, PR, Brazil	MTA based sealer	Base and Catalyst were mixed in equal amounts
		Salicylate resin, diluting resin, natural resin, bismuth trioxide, nanoparticulated silica, MTA, pigments	
Tubli Seal	Sybron Endo, Glendora, CA, USA	Zinc oxide eugenol-based sealer	Base and Catalyst were mixed in equal amounts
		Base: zinc oxide	
		Catalyst: eugenol	

Preparation of the Samples

A total of 80 cylindrical acrylic blocks with 4 mm internal diameter central holes and 2 mm in height were prepared. Two types of cements, WMTA and Biodentine, were prepared according to the manufacturers' instructions. The holes were filled with MTA and Biodentine, and coated with wet cotton pellets and a temporary filling material (Cavit, 3M ESPE, Seefeld, Germany). The blocks were stored at 37 °C and 100% humidity for 96 hours for the cements to set.

Then, the temporary filling material was removed, but the WMTA and Biodentine surfaces were not rinsed or polished. The samples were further divided into 4 subgroups (10 blocks each) corresponding to the four root canal sealers; Groups 1a and 2a: Sealapex, Groups 2a and 2b: AH plus, Groups 3a and 3b: MTA Fillapex, Groups 4a and 4b: Tubli-Seal root canal sealer. The sealers were placed into cylindrical plastic tubes (2 mm in internal diameter and 2 mm in height) and the tubes were placed in the center of the WMTA and Biodentine surface. After the setting process, the plastic tubes were removed carefully and the samples were stored at 37 °C and 100% humidity for 48 hours.

The shear bond strength between the sealers and WMTA or Biodentine was determined using a Universal testing machine (Lloyd LRX, Lloyd Instruments LTD, Fareham, UK). The chisel edge of a stainless steel plunger was inserted into the cement/sealer interface at a 0.5 mm/min crosshead loading speed **(Figure 1)**. SBS was expressed in MPa and calculated by dividing the peak load at failure by the sample surface area.

All statistical analyses were performed with the IBM SPSS 20.0 software. A one-way analysis of variance (ANOVA) and post hoc Tukey's tests were used for data analysis at the 0.5% significance level.

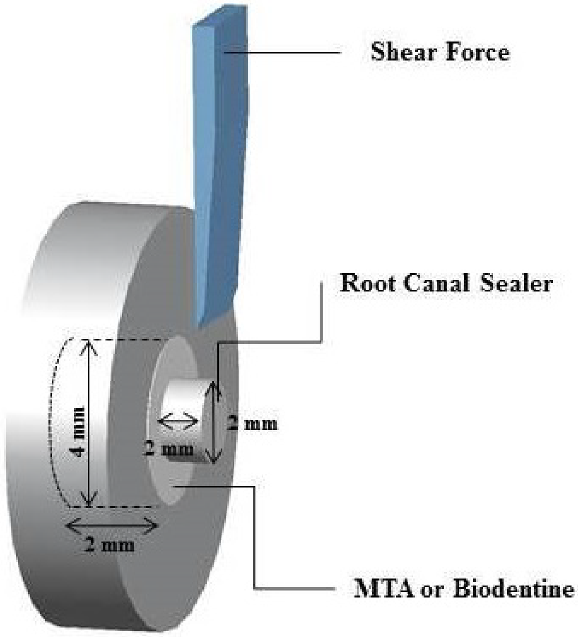

Figure 1. Schematic illustration of the sample design and shear bond test.

RESULTS

Table 2 showed the descriptive statistics of shear bond strengths for groups. The presence of significant differences between the experimental groups was revealed by the ANOVA ($p<0.05$). The highest (10.51 MPa) and the lowest (1.87 MPa) bond strength values were recorded for AH Plus/Biodentine and Tubli Seal/Biodentine, respectively. There were no significant differences in the SBS values between Tubli-Seal and MTA Fillapex. Sealapex showed a significantly higher bond strength compared with Tubli-Seal and MTA Fillapex. There were no significant differences between WMTA and Biodentine in all root canal sealer groups.

Table 2. Mean shear bond strength values with standard deviations of each sealer.

Groups	Subgroups	Mean (MPa)
WMTA	Sealapex	3.84 ± 1.04^{a}
	AH Plus	9.03 ± 2.29^{b}
	Tubli-Seal	1.98 ± 0.61^{c}
	MTA Fillapex	$2.08 \pm 0.53c^{d}$
Biodentine	Sealapex	4.74 ± 1.09^{a}
	AH Plus	10.51 ± 2.46^{b}
	Tubli-Seal	1.87 ± 0.63^{c}
	MTA Fillapex	$2.58 \pm 1.03c^{d}$

Subgroups identified by the same superscript letters are not significantly different in each group ($P>0.05$). Different letters identify significant differences within subgroups ($P<0.05$).

DISCUSSION

Clinically, root repair materials, such as MTA and Biodentine, are used in apexification treatment; root perforation repair, apical resection treatment, and root canal filling materials are applied on these materials. Thus, root canal sealers are in direct contact with root canal repair materials. In these types of restorations, the bond between root canal repair materials and root canal sealers plays a critical role in the treatment success. Therefore, the bond strength between different root canal sealers and WMTA and Biodentine was investigated in the present study.

The most common method to evaluate adhesive properties of restorative materials is bond strength test. This has become a well-recognized method to evaluate an important aspect of *in vitro* performance of restorative materials [14,15]. Different bond strength methods have been used, including push-out, micro-tensile and shear bond tests [16]. Shear bond studies use standardized samples and are more sensitive than the push-out test. So a shear bond strength test was used in this study to evaluate the adhesive properties of WMTA and Biodentine to different endodontic sealers.

The bond strength between two materials is of maximum importance for the quality of fillings. It has been estimated that bond strengths of 17 to 20 MPa may be required to sufficiently resist contraction forces and produce gap-free restoration margins [17,18]. Ajami et al. [19] evaluated the bond strength of composite and resin-modified glass ionomer cement (RMGI) to MTA, CEM cement and experimental MTA cement. They concluded that the composite showed the highest bond strength, with a mean value of 18 MPa value, while no significant differences were observed between shear bond strengths of the cements (MTA, CEM and experimental MTA) [19].

Cantekin et al. [9] reported that Biodentine showed higher shear bond scores, and only this group reached an optimal shear bond value (17 MPa), compared to MTA, when used with the MB composite. Our findings demonstrated that AH plus with Biodentine showed the highest bond strength, and only this group reached optimal shear bond values, with a mean SBS value of 10.51 MPa. When the SBS values were determined for all groups, none of the sealers had optimal bond strength to WMTA or Biodentine. We found that Tubli-Seal exhibited the lowest bond strength to both WMTA and Biodentine. Biodentine and WMTA had significantly similar SBS values with all canal sealers.

Effect of different conditions on bond strength of various root canal sealers to dentin were investigated in several studies [20-23]. However, this was the first study to evaluate the shear bond strength of the AH Plus, Tubli-Seal, MTA Fillapex, and Sealapex root canal sealers to the MTA and Biodentine substrates. Since there is no information about the bonding of root canal sealers to MTA or Biodentine, our results were compared with previous sealer-dentin bonding results. Sağsen et al. determined that MTA Fillapex had the lowest push-out bond values to root dentin compared with the AH plus and iRoot SP sealers. The authors attributed the low bond strength to the formation of an interfacial layer with tag-like structures of MTA Fillapex [20]. In previous studies, Sealapex showed higher bond strength values than MTA Fillapex to root canal dentin [21,23]. The results of the present study results are consistent with those of previous studies [20,21].

The highest bond strength values of AH Plus observed in this study are corroborated with the results of earlier studies [21,23,24]. The higher bond strength of AH Plus can be due to its ability to react with exposed amino groups in collagen, resulting in the formation of covalent bonds between the resin and collagen [22].

CONCLUSION

Despite the limitations of this study, MTA and Biodentine demonstrated similar shear bond scores when used with the different root canal sealers. AH Plus had the highest bonding values to MTA and Biodentine when compared with the other sealers. For a better understanding of adhesion of root canal sealers to WMTA or Biodentine, further investigations are certainly needed.

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