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The Effect of Intracanal Irrigants on Push out Bond Strength of CEM, Root MTA and Angelus MTA Cements to the Dentin Wall

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ABSTRACT

Background and Objective: To reduce microbial contamination in cases such as perforation treatment, it is necessary to use irrigants after cement placement. The aim of the present study is to investigate the effect of intracanal irrigants on the push out bond strength of CEM, Root MTA and Angelus MTA cements to the dentin wall.

Methods: In this laboratory research, 150 cross-section samples from the mid-root region of single canal teeth without caries with a thickness of 1 mm, which were randomly divided into 3 groups of 50 and filled with CEM cement, Root MTA or Angelus MTA, were examined. After the cements were set, the samples of each group were divided into 5 subgroups of 10; 4 subgroups were cleaned with sodium hypochlorite, EDTA, normal saline, 2% chlorhexidine for 30 minutes, and one subgroup was not cleaned as a control group. Then, the push out bond strength of cement with the dentin wall (MPa) and the failure pattern of the samples were evaluated.

Findings: Different cleaning methods did not show any significant effect on the bond strength of CEM, Root MTA and Angelus MTA cements. In the cleaning method with saline, the bond strength of Angelus MTA (6.3±1.98) was higher than Root MTA (2.1±3.61) (p=0.004). In the cleaning method with 2% chlorhexidine, the bond strength of Angelus MTA cement (8.72±3.13) was higher compared to CEM (3.87±1.35) and Root MTA (4.66±1.76) (respectively p<0.001 and p=0.001). The most common type of failure in the Angelus MTA group was of the adhesive type, and in the CEM cement and Root MTA groups, it was of the mixed type.

Conclusion: The results of the study showed that different cleaning methods have no effect on the push-out bond strength of the examined cements.

Keywords: *Intracanal Irrigants, CEM Cement, MTA.*

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Introduction

The aim of intracanal treatment is to create proper seal in the root canal and prevent the exit of microorganisms to the periradicular tissue (1). Most root end filling materials have shown problems such as solubility, microbial leakage and moisture absorption (2-4). Calcium silicate-based cements such as MTA (Mineral Trioxide Aggregate) are used in treatments such as pulpal regeneration, apexogenesis, perforation repair and apical plug creation (5, 6). MTA has high biocompatibility and is able to stimulate healing and osteogenesis (7). Despite several advantages, MTA has problems such as tooth discoloration, long setting time, and high price (8). CEM (calcium enriched mixture) endodontic cement is easier to use, has better flowability and shorter setting time compared to MTA (9). Due to these favorable characteristics, CEM is also a suitable filler for repairing root perforation and filling the end of the root (10, 11).

Marginal compliance and bond strength of root-end filling materials is one of the important factors in the success of root canal treatment because most of the endodontic failures are caused by leakage of stimulators into the periapical tissues (12, 13). On the other hand, in order to reduce the bacterial contamination inside the canal in cases such as creating an apical barrier and perforation, we are required to use cleaning agents inside the canal after placing the sealing cements. Therefore, it seems logical to evaluate the effect of irrigants on the bond strength of these cements to the dentin wall. The present study was conducted with the aim of investigating the effect of intracanal irrigants on the push out bond strength of CEM, Root MTA and Angelus MTA cements to the dentin wall.

Methods

This experimental laboratory study was carried out after approval by the Ethics Committee of Babol University of Medical Sciences with the code IR.MUBABOL.REC.1400.162, and it was conducted on 150 cross-section samples from the mid-root region of extracted single canal anterior teeth with a thickness of 1 mm. The inclusion criteria were the absence of caries, the absence of severe curvature in the mid-root region, the absence of internal and external corrosion and irregularities within the canal, and the absence of previous root canal treatment history.

First, a periapical radiograph was prepared from each tooth, so that the target tooth was excluded from the study in case of not meeting the inclusion criteria. All samples were disinfected by 0.5% chloramine T solution and the soft tissue residues were removed from the root surface by moist sterile gauze. The samples were cut by a diamond blade of a digital cutting machine (NEMO, Mashhad, Iran) under water cooling. The cut section was prepared by Gates Glidden Drill (number 1 to 5) in a diameter of 1.3 mm.

The samples were randomly divided into 3 groups of 50 and filled with CEM cement, Root MTA or Angelus MTA. The samples were placed in a moist gauze and incubated for 1 day at 37 °C and 100% humidity to complete the cement setting. After the cements were set, the samples of each group were divided into 5 subgroups of 10; 4 subgroups were cleaned with sodium hypochlorite, EDTA (Ethylene Diamine Tetra Acetic Acid), normal saline, chlorhexidine 2% for 30 minutes and one subgroup was not cleaned as a control group. After 30 minutes exposure of the samples to irrigants, all samples were cleaned with 10 ml of distilled water.

In order to measure the bond strength of cements to the dentin wall, the push out bond strength test was carried out on samples (Figure 1) using a plunger with a diameter of 0.8 mm and at a speed of 1 mm per minute by a 200 kg load cell (a universal testing machine [Koopa, Sari, Iran]) until failure occurred and the maximum pressure withstood was recorded as bond strength. Then, the samples were examined by a stereo microscope (Dwinter, Italy) to evaluate the failure pattern (Figure 2).

Data analysis was done using SPSS version 22. Analysis of variance was used to compare the mean push out bond strength of root canal filling materials by different cleaning methods and also according to the root canal filling materials. Furthermore, to compare them two by two, Tukey's Post-hoc test was used and $p<0.05$ was considered significant.

Figure 1. Push out bond strength test on the samples

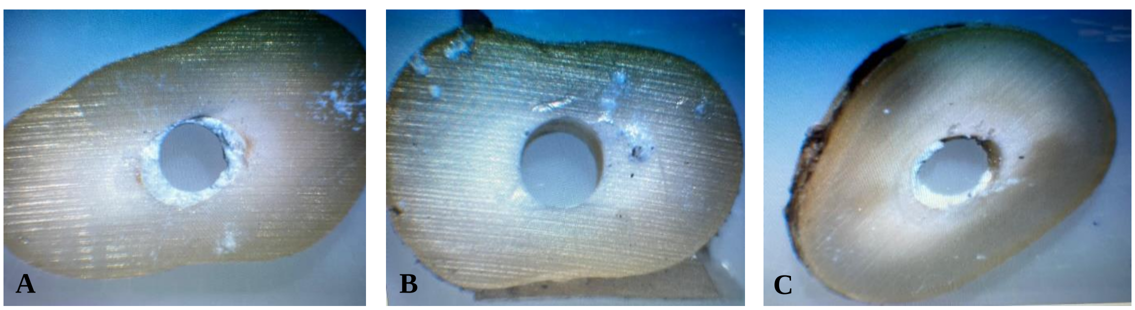

Figure 2. Types of failure patterns in the studied samples. A) Cohesive, B) Adhesive, C) mixed

Results

The use of different cleaning methods did not affect the bond strength of Root MTA, Angelus MTA and CEM cement. However, the bond strength of different cements showed a significant difference in two types of chlorhexidine 2% and saline cleaning methods ($p<0.001$ and $p=0.005$, respectively). In the two-by-two comparison of the groups, in the cleaning method with saline, the bond strength of Angelus MTA (6.3±1.98) was higher than Root MTA (2.1±3.61) ($p=0.004$). In the cleaning method with 2% chlorhexidine, the bond strength of Angelus MTA cement (8.72±3.13) from CEM (3.87±1.35) and Root MTA (4.66±1.76) (respectively $p<0.001$ and $p=0.001$) was higher (Table 1).

In the present study, most of the failures in all cleaning methods were of the mixed type. Moreover, regardless of the type of irrigant, most of the failures in the Root MTA and CEM cement groups were of the mixed type, and in the Angelus MTA group, of the adhesive type (Table 2).

Table 1. Mean push out bond strength in the studied groups according to different cleaning methods

Study groups	Angelus MTA Mean±SD	Root MTA Mean±SD	CEM Mean±SD	p-value
Control	7.23±2.93	4.3±3.27	4.06±3.09	0.057
Normal saline	6.3±1.98[a]	2.16±3.61 b	4.24±1.7[ab]	0.005
Sodium hypochlorite 5.25%	7.95±2.67	5.36±3.7	4.93±3.71	0.118
EDTA 17%	7.32±4.16	3.68±2.95	4.49±3.59	0.077
Chlorhexidine 2%	8.72±3.13[b]	4.66±1.76 a	3.87±1.35[a]	0.001
p-value	0.491	0.224	0.933	

[**]Different English letters in each line show a significant difference at the level (α=0.05) between both groups.

Table 2. Frequency of failure patterns in the studied groups

Study groups	Angelus MTA Number(%)	Root MTA Number(%)	CEM Number(%)	Total Number(%)
Control				
Adhesive	4(40)	0(0)	0(0)	4(13.3)
Cohesive	2(20)	1(10)	3(30)	6(20)
Mix	4(40)	9(90)	7(70)	20(66.7)
Normal saline				
Adhesive	4(40)	1(10)	1(10)	6(20)
Cohesive	3(30)	1(10)	3(30)	7(23.3)
Mix	3(30)	8(80)	6(60)	17(56.7)
Sodium hypochlorite 5.25%				
Adhesive	4(40)	0(0)	0(0)	4(13.3)
Cohesive	2(20)	4(40)	3(30)	9(30)
Mix	4(40)	6(60)	7(70)	17(56.7)
EDTA 17%				
Adhesive	6(60)	0(0)	1(10)	7(23.3)
Cohesive	1(10)	4(40)	1(10)	6(20)
Mix	3(30)	6(60)	8(80)	17(56.7)
Chlorhexidine 2%				
Adhesive	7(70)	0(0)	0(0)	7(23.3)
Cohesive	0(0)	3(30)	1(10)	4(13.3)
Mix	3(30)	7(70)	9(90)	19(66.3)
Total				
Adhesive	25(50)	1(2)	2(4)	28(18.7)
Cohesive	8(16)	13(26)	11(22)	32(21.3)
Mix	17(34)	36(72)	37(74)	90(60)

Discussion

According to the results of this study, different cleaning methods had no significant effect on the bond strength of Root MTA, CEM cement and Angelus MTA. A study by Sahebi et al., in agreement with the results of the present study, showed that different irrigants (5.25% sodium hypochlorite, 2% chlorhexidine and saline solution) have no effect on the push out bond strength of Angelus MTA and CEM cements (14). In a study by Sadegh et al., there was no significant difference in Angelus MTA bond strength after cleaning with SmearClear, chlorhexidine 2% and sodium hypochlorite. However, the bond strength of the saline group was significantly higher than the sodium hypochlorite and SmearClear groups, which could be due to the longer contact time of the samples with normal saline in their study compared to the present study. That's because saline can have a positive effect on the size of MTA crystals and complete the MTA hydration process (15-17).

There is conflicting information about the effect of sodium hypochlorite on the bond strength of MTA to the dentin wall. Guneser et al. showed in a study that the effect of sodium hypochlorite on the push out bond strength of MTA cement is not significant, which is consistent with the results of the present study (16). Some other researchers have stated that the accelerated immersion of MTA in 3.5% sodium hypochlorite leads to an increase in push out bond strength. In fact, the use of sodium hypochlorite can increase the size and amount of calcium hydroxide crystals in accelerated MTA, while it has a destructive effect on the formation of calcium hydroxide in nonaccelerated MTA (18).

The studies by Gokturk et al. showed that chelating agents significantly affect the resistance to separating forces, and EDTA has a higher level of resistance to separating forces compared to maleic acid and AgNPs-chitosan. The results of this study were not consistent with the present study. In the present study, after the initial setting of the cements for 24 hours, the samples were exposed to different cleaning solutions, while in the study of Gokturk et al., the smear layer was removed before placing the cements in the cavities. It seems that removing the smear layer by EDTA before placing MTA inside dentin cavities increases penetration into dentin tubules and increases its push out bond strength (19).

Regarding the effect of 2% chlorhexidine on MTA bond strength, the study of Guneser et al. showed that the push out bond strength of MTA cement decreases significantly when exposed to 2% chlorhexidine after 10 minutes of cement setting (16). Nevertheless, the results of the present study and the study of Sahebi et al. did not show any significant effect in this case (14). The reason for the difference in the results of these studies can be due to the difference in the initial setting times of the cements. Based on the results of these studies, it is better to postpone cleaning with 2% chlorhexidine to 24 hours after MTA setting, and avoid contact of 2% chlorhexidine solution with MTA in one-session endodontic treatments.

In the present study, in the cleaning method with normal saline, the bond strength of Angelus MTA was significantly higher than Root MTA. In addition, when cleaning the samples with 2% chlorhexidine, the bond strength of Angelus MTA was significantly higher than Root MTA and CEM cement. However, in other cases of cleaning (sodium hypochlorite and EDTA 17%), no significant difference was observed between the bond strength of different cements. The results of a study by Adl et al. showed that MTA bond strength is significantly higher compared to CEM cement, which was consistent with the present study (1). In the study of Tavasoli et al., there was no significant difference in the push out bond strength of Root MTA and CEM cements after 72 hours (20). In the present study, these two cements showed no significant difference in terms of push out bond strength in any of the cleaning methods.

Based on the findings of their study, Ertas et al. stated that the push out bond strength of ProRoot MTA cement is significantly higher than Angelus MTA and CEM cement and there is no significant difference between the bond strength of Angelus MTA and CEM cement (7). Meanwhile, the study of Sahebi et al. showed that the push out bond strength of CEM cement is significantly higher compared to Angelus MTA (14). The results of these two studies were not consistent with the results of the present study. One of the factors affecting the bond strength of cements is the removal of the smear layer. This process was not done in the present study as well as the study of Ertas et al., but in the study of Sahebi et al., the removal of the smear layer was done before placing the cements. Based on these studies, removing the smear layer significantly increases the push out bond strength of CEM cement, while this process has no effect on the bond strength of MTA.

In the present study, most of the failures in all cleaning methods were of the mixed type. In addition, regardless of the type of irrigant, most of the failures in the Root MTA and CEM cement groups were of the mixed type, and in the Angelus MTA group, of the adhesive type. In the study of Sadegh et al., most of the failure patterns observed in MTA in each of the cleaning methods with SmearClear, sodium hypochlorite 2.5%, chlorhexidine 2% and normal saline were of the mixed type (15). In the study of Tavasoli et al., the most common type of failure in both CEM and Root MTA cements was the mixed type (20).

In the study of Gokturk et al., the most common type of failure in MTA Angelus was the cohesive type (19). Sahebi et al. reported the most common type of failure in MTA Angelus as the mixed type and in CEM cement as cohesive type (14). Sobhnamayan et al. stated that the most common type of failure observed in CEM cement is of cohesive type (21). The study of Adl et al. showed that the most common type of bond failure in MTA group is adhesive type and in CEM cement group is cohesive type (1). The results of these studies are not consistent with the results of the present study, which can be attributed to the existence of different variables in the design of these studies. For example, the cause of more reports of cohesive failure in CEM cement can be due to the process of removing the smear layer, as this process was not considered in the present study, while in the study of Adl et al., Sahebi et al., and Sobhnamayan et al., this process has been performed, which can increase the bond strength of CEM cement, and as a result, the bond created between cement and dentin is stronger than the cohesive strength of the cement, and ultimately, most of the failures will be of the cohesive type (1, 14, 21).

In the present study, Root MTA and CEM cement showed almost similar performance in terms of bond strength. However, compared to Angelus MTA cement, they had lower strength. Therefore, it is possible to suggest the use of Angelus MTA in one-session processes in patients who experience a lot of mechanical forces and stress on their restored teeth and roots. Nevertheless, the strength of the push out bond to the dentin wall is only one of the factors affecting the clinical efficiency of cements and other factors must be considered as well. It should be noted that evaluating bond strength is only one of the factors involved in choosing a suitable cement, and other factors such as microbial leakage, compressive strength, wear resistance, etc. should also be considered (20).

The results of the study showed that different cleaning methods have no significant effect on the bond strength of Root MTA, CEM cement and Angelus MTA. In the cleaning method based on normal saline, the bond strength of Angelus MTA was significantly higher than Root MTA. In the cleaning method with 2% chlorhexidine, the bond strength of Angelus MTA was significantly higher than Root MTA and CEM cement. Root MTA and CEM cement had no significant difference in push out bond strength in any of the cleaning methods.

Conflict of interest: There is no conflict of interest in this study.

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