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Evaluate And Compare the push-out bond Strength of Recent root Perforation Repair Materials after Different Irrigation regimens

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ABSTRACT

Introduction: The aim of this study was to evaluate and compare the push-out bond strength of recent root perforation repair materials after different irrigation regimens.

Materials and methods: Mid-root dentine of eighty single rooted human permanent teeth were horizontally sectioned into 1-mm-thick slices. The canal space of each dentin slice was enlarged with a diamond bur to 1.4 mm in diameter. The samples were divided into 2 groups (n = 40), and the following materials were placed, respectively: Biodentine, ProRoot MTA. The samples were wrapped in wet gauze for 10 minutes and divided into 4 subgroups (n = 10) to be immersed into QMix,CHX,17% EDTA+3.5% sodium hypochlorite, or saline for 30 minutes. After 30 minutes of immersion, all samples were removed from the test solutions, rinsed with distilled water and allowed to set for 48 hrs at 37degree Celsius with 100% relative humidity in an incubator. The push-out bond strength values were measured by using a universal testing machine.

Results: The push-out bond strength of biodentine was highest as compared to MTA group ($p<.05$). Push out bond strength of MTA was decreased after immersing in irrigating regimens (2% CHX, QMix, 3.25%NaOCL+17% EDTA) as compared to saline group and shows statistical significant difference ($p<.05$). Push out bond strength of biodentine group remain unaffected after exposure to endodontic irrigants.

Conclusion: Push out bond strength of MTA group was significantly affected after exposure to different endodontic irrigants where as endodontic irrigants did not affect the push-out bond strength of biodentine. The push-out bond strength of biodentine was significantly higher as compared to MTA group.

Key words: MTA, Biodentine, push-out bond strength, Endodontic irrigants.

INTRODUCTION

The root end filling material should possess ideal properties such as biocompatibility, dimensional stability, radiopacity, ability to set in a wet environment, antibacterial properties, easy handling, adequate compressive strength and hardness, osteoinductive and osteoconductive properties and adherence to the canal walls to provide a good apical seal.[1]

Clinically the operator should immediately repair the furcation perforations with an endodontic material in order to minimize the bacterial contamination and the irritation of the periodontal tissue because of the usage of endodontic irrigants.[2] Mineral trioxide aggregate consists of fine powder of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetra calcium aluminoferrite and bismuth oxide. However, MTA is associated with many critical problems such as prolonged setting time, difficult handling characteristics, possible tooth discoloration and high cost. Many attempts to improve the handling properties of MTA by adding calcium compounds as a setting accelerator or other materials to enhance viscosity have been made.[3]

Biodentine is a relatively new material introduced as a dentine substitute. Biodentine powder is mainly composed of highly pure tricalcium silicate, which regulates the setting reaction. Other components are calcium carbonate (filler) and zirconium dioxide (radiopacifier). The liquid contains calcium chloride (setting accelerator), water reducing agent (super-plasticizer) and water. The super-plasticizer reduces the viscosity of the cement and improves handling. [4] After repairing the furcal preparation, endodontic treatment should be performed with various irrigants including 2% CHX, saline, sodium hypochlorite and EDTA solution to disinfect the root canal system.

Chemical irrigants can alter the dentin surface composition and therefore, affect its interaction with the root canal filling materials. However, the contact of root perforation materials with these medications could affect their properties or interfere with their bond strength to radicular dentin.[5,6]

Sodium hypochlorite (NaOCl) has been widely accepted as the endodontic irrigant of choice because of its antimicrobial and tissue-dissolving properties. The use of chlorhexidine gluconate (CHX) as an irrigant during root canal therapy has been suggested based on its antibacterial effect, substantivity and less cytotoxicity than NaOCl. [7]

Ethylenediaminetetraacetic acid is the most commonly used chelating agent which remove smear layer from root canal walls. As a result of its ability to form complexes with calcium ions, EDTA is commonly used to remove the smear layer in nonsurgical endodontic treatment. The residual EDTA in the root canal system may chelate with calcium ions released from MTA during hydration and disturb the precipitation of C-S-H gel.[8]

Nandini *et al*. showed that 2% CHX decreased the surface hardness of set white MTA significantly and suggested that CHX irrigation within 24 h of placement of white MTA should be avoided.[9]

Agarwal et al reported that 17% EDTA reduced the bond strength of MTA. On the other hand biodentine showed adequate bond strength to radicular dentin after exposure to 2% CHX and 3.5% NaOCL as compared with MTA.[10]

Recently, QMix irrigant for smear layer removal with added antimicrobial agents has been developed. It contains EDTA, CHX, and a detergent. QMix is a ready-to-use clear solution; no chair side mixing is necessary. Hence in the present study, the push-out bond strength of recent root perforation materials (MTA and biodentine) after different irrigation regimens has been compared. [11]

MATERIALS AND METHODS

Freshly extracted single-rooted human canine teeth were used. The crowns of all teeth were removed, and the midroot dentin was sectioned horizontally into slices with a thickness of 1.0 mm by using a water-cooled low-speed IsoMet diamond saw (Buehler, Lake Bluff, NY). In each slice, the space of the canal was enlarged with a 1.4-mm-diameter diamond bur. The sections were divided into two main groups: group 1 MTA and group 2 Bio dentine.

The test materials were incrementally placed into the canal spaces and condensed. Excess material was trimmed from the surface of the samples with a scalpel. Subsequently, the samples were wrapped in wet gauze, placed in an incubator, and allowed to set for 10 minutes at 37 degree celsius with 100% humidity. Immediately after incubation, the samples were divided into 4 subgroups(n=10) to be immersed in different irrigating solutions saline, 2% CHX, 3.25% NaOCL + EDTA, QMix. After 30 minutes of immersion, all samples were removed from the test solutions, rinsed with distilled water, and allowed to set for 48 hours at 37degree celsius with 100% humidity in an incubator.

Push-out Test : The push-out bond strength values were measured by usinga universal testing machine (Instron Universal test machine; Elista, Istanbul, Turkey). The compressive load was applied by exerting a download pressure on the surface of the test materialin each sample with the Instron probe moving at a constant speed of1 mm/min. The plunger had a clearance of approximately 0.2 mm from the margin of the dentinal wall to ensure contact only with the test materials.

The maximum force applied to materials at the time of dislodgement was recorded in new tons. The push-out bond strength inmegapascal (MPa) was calculated by dividing this force by the surfacearea of test material (N/2prh), where p is the constant 3.14, r is the rootcanal radius, and h is the thickness of the root dentin slice in millimeters. Data were analyzed by using1-way analysis of variance and post hoc Tukey tests.

RESULTS

Table 1: Mean and standard deviation of all samples obtained

	N	Mean	Std. Deviation	F-value	p-value
CHX	10	5.67	0.70	1.8	0.157
Qmix	10	5.66	2.02		
Saline	10	6.66	0.52		
NaOCl+EDTA	10	5.85	0.14		
Total	40	5.96	1.14		
Values					
	Sum of Squares	**Df**	**Mean Square**	**F**	**p-value**
Between Groups	6.698	3	2.233	1.842	0.157
Within Groups	43.634	36	1.212		
Total	50.333	39			

Table 2: Mean and standard deviation of biodentine samples

	N	Mean	Std. Deviation	F-value	p-value
CHX	10	2.37	0.07	3791.0	<0.001
QMix	10	3.22	0.05		
Saline	10	5.89	0.12		
NaOCl+EDTA	10	3.06	0.06		
Total	40	3.63	1.36		
Values					
	Sum of Squares	**df**	**Mean Square**	**F**	**p-value**
Between Groups	72.256	3	24.1	3791.0	<0.001
Within Groups	0.229	36	0.0		
Total	72.485	39			

Table 1 Shows the mean values and standard deviations of thepush-out bond strength (MPa) of allgroups. The push-out bond strength of MTA was less as compared to biodentine (p<.001). The push-out bond strength of MTA group has been statistically decreased after immersing in CHX, QMix EDTA+3.5%NaOCL group when compared with saline group.. The push-out bond strength in biodentine group has not been statistically decreased in CHX, QMix, EDTA+NaOCl group when compared with saline group.(Table 2)

DISCUSSION

The main aim of root end filling is to prevent the movement of the bacteria and diffusion of bacterial products from the root canal into periapical tissues and vice versa. Ideal apical seal prevents ingress of residual irritants into the periapical region and percolation of periapical tissue fluid in to the canal system. Various root end filling materials have been tested for their sealing ability and newer materials are still under research. The root end filling material should possess ideal properties such as biocompatibility, dimensional stability, radiopacity, ability to set in a wet environment, antibacterial properties, easy handling, adequate compressive strength and hardness, osteoinductive and osteoconductive properties and adherence to the canal walls to provide a good apical seal.[1]

In the present study, calcium silicate materials (BD and MTA) were exposed to the irrigants 10 minutes after placement while the materials were still in the setting stage to simulate the clinical situation for repairing the root and furcal perfoartions in single visit endodontic therapy. The final setting time of BD is 45 minutes and that of MTA is 165 minutes.

In this study, Biodentine was more resistant to dislodgement forces than MTA (p<.001). This finding is in agreement with the Guneser et al, and could be attributed to the ability of BD to form tag like structures, which increased the resistance to dislodgement forces in that study as well. The biomineralization ability of Biodentine, most likely through the formation of tags, may be the reason of the dislodgement resistance.

A possible explanation to this result is that the setting accelerator in biodentine ($CaCl_2$) may alter the chemical composition, surface area, and characteristics of the pores of cements, providing the advantages of increased resistance to compression. A smaller particle size and uniform components might have a role in better interlocking of Biodentine with the dentin. The adhesion of Biodentine to dentinal tubules may also result from the tag-like structures within the dentinal tubules leading to micromechanical anchor.[12]

Exposure to 2% CHX, even though it is not an acid, may result in a reduced surface hardness, a decreased sealing ability a slower setting time, and a lower resistance to dislodgement forces.[13]

In this study, immersing MTA in CHX after 10 minutes of setting resulted in a statistically significant decrease push-out bond strength as compared to saline group. (ie, from 5.89 to 2.37 MPa). On the contrary, CHX could not affect the push-out bond strength of Biodentine as it could on the MTA. The push-out bond strength of biodentine when kept in CHX group was 5.67 MPa as compared to 2.37 MPa in MTA group.

This result was consistent with the results of Hong et al, who showed that 2% CHX reduced the push-out strength of accelerated MTA. Nandini et alshowed that 2% CHX decreased the surface hardness of set MTA significantly and suggested that CHX irrigation within 24 hours of placement of MTA should be avoided.[9]

Aggarwal et al found that 2% CHX irrigant reduced the microhardness and flexural strength of MTA.[10]
Holt et al found a significant decrease in the compressive strength of MTA when mixed with CHX. Consequently, MTA might disintegrate after exposure to certain chemicals. WMTA showed surface dissolution when exposed to 2% CHX, and it has been recommended to avoid irrigating root canals with CHX solution when WMTA is used during endodontic treatment.[13]

In this study, the push-out bond strength of both MTA and biodentine group was not affected by saline group. However, the normal saline environment offers more nucleation sites for the hydration of MTA, due to the higher Na+ and Cl- contents; this causes the formation of greater numbers of needle-like crystals.[7]

In this study, EDTA+NaOCL revealed decrease in push-out bond strength as compared to saline group from (5.89-3.06 MPa) in MTA group (p<.001) but no statistical significant difference was seen in biodentine group.(p=.157) (6.66-5.85 MPa). The negative effects of irrigants with low pH on the setting of MTA are well known. The use of acids such as EDTA have been shown to disrupt the formation of C–S–H gel during hydration of MTA. A recent report also suggested that sodium hypochlorite (NaOCl) interacted with MTA, which was characterized by absence of the Portlandite phase, in addition to discoloration of the material.[14]

Recently, an EDTA-based formulation was developed as final rinse solution. QMix (Dentsply Tulsa Dental, Tulsa, OK, USA) contains EDTA, chlorhexidine and a surfactant agent. This solution exhibits a lower level of toxicity than 17% EDTA, which also has low toxicity and antimicrobial activity associated with the ability to remove the smear layer. [15]

The underlying principle of including surfactant in QMix is to lower the surface tension of the solution and increase its wettability, thus enhancing the flow of the irrigant into the root canal and its contact with the smear layer and underlying dentin.In this study, QMix did not affect the push-out bond strength of biodentine to root dentin unlike MTA. Push out bond strength of biodentine when exposed to QMix iriigant was 5.66MPa and showed statistical significant difference with the MTA group (3.22MPa) (p=.001).[16,17]

Another study Elnaghy conducted to assess the influence of EDTA associated with chlorhexidine on the adhesion of glass fiber posts cemented with resin cement in the root canal, and showed that QMix and EDTA associated with chlorhexidine provided the best adhesion results.[18]

The exact changes that occur in these materials are not within the scope of this work and needs further characterization. Future research should also investigate how the compressive strength of these cements varies with time. The alteration on the physical properties of biodentine in the irrigant solutions should be studied further before advocating the clinical application of biodentine successively with these irrigants.

CONCLUSION

Based on this invitro study, the following conclusion can be made:

1. The force needed for the displacement of biodentine from root dentin was significantly higher than MTA.
2. Saline solution increased the push out bond strength of MTA, where as CHX reduced it.
3. It is recommended that care should be taken to prevent the contact of CHX solution with MTA in single visit endodontic therapy procedures. Further research is needed to warranty clinical usage of biodentine.

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