The Effect Of Root Canal Irrigants On The Push –out Bond Strength Of Biodentine

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Key words
Biodentine, push out , MTAD, QMi*x*

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Abstract

Aims: The aim of This study was to evaluate the effect of some endodontic irrigants on the push-out bond strength Biodentine in comparison with Mineral trioxide aggregate (MTA) and Glass ionomer cement (GIC).**Materials and Methods**: Mid root dentine of single rooted teeth was horizontally sectioned into 1-mm-thick slices. The canal space of each dentine slice was enlarged with a diamond bur to 1.4 mm in diameter. The samples were divided into 3 groups (n=21)for each, and the following materials were placed, respectively: Biodentine(Septodont, Saint Maur des Foss'es, France),MTA(Dentsply, TulsaDental, Tulsa, OK),and GIC(Medifil, PROMEDICA, Germany).The samples were wrapped in wet gauze for 30 minutes to ensure setting of the materials and then divided into 3 subgroups (n=7)for each, to be immersed into QMix ((Dentsply Tulsa Dental, Tulsa, OK, USA), Bio Pure MTAD (Dentsply Tulsa Dental),and saline solutions for 30 minutes. No irrigant was placed over any test material in the other three subgroups. After incubation for 48 hours, the dislodgement resistance of the samples was measured (with and with exposure to the irrigant solutions) using a universal testing machine. Then the samples were examined under stereomicroscope to determine the nature of the bond failures. **Results:** The lowest push-out bond strength was observed in the MTA group. Biodentine displayed a significantly higher resistance to displacement than the MTA group. Exposure to QMix, MTAD, and saline solutions did not affect the resistance to displacement of the Biodentine and GIC groups, whereas MTA lost strength after exposure to the irrigant solutions ,but the difference was not significant. **Conclusions**: The PBS of Biodentine and GIC was not affected by the irrigant solutions. Contact with the irrigant solutions did not have a significant effect on the failure modes of the tested materials.

Introduction

Root perforation connect root canal spaces with periodontal tissues. The connection may occur as result of iatrogenic causes during root canal treatment (at the level of floor of the coronal cavity or at different levels of the root) or during prosthetic treatment of post canal trioxide aggregate(MTA), composite resin, glass ionomer cement and calcium hydroxide, most of these penetration. [1] An ideal perforation repair material should provide a tight seal between the materials show significant short comings in one or more of the following areas: solubility, leakage, biocompatibility, handling properties, and moisture incompatibility. [4,5] Despite the numerous favorable properties of MTA that support its clinical use when compared with the traditional materials, there are several critical drawbacks such

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as prolonged setting time, difficult handling characteristics, high cost, and potential of discoloration.[6,7,8,9]
Biodentine is a new calcium silicate–based materials that have been developed recently aiming to improve MTA shortcomings. [10,11]
Biodentine™ (Septodont, Saint Maur des Foss'es, France) is a high-purity calcium silicate–based dental material composed of tricalcium silicate, calcium carbonate, zirconium oxide, and a water-based liquid containing calcium chloride as the setting accelerator and water-reducing agent. Biodentine is recommended for use as a dentin substitute under resin composite restorations and an endodontic repair material because of its good sealing ability, high compressive strengths, short setting time, [12] biocompatibility,[13] bioactivity,[14] and biomineralization properties.[15]
After repairing the furcal perforation, endodontic treatment should be performed with various irrigants including chlorhexidine gluconate (CHX), sodium hypochlorite (NaOCl) solutions at different concentrations to disinfect the root canal system. [16] However, this procedure causes unavoidable contact of the irrigants with the repair materials. In the past decade, considerable efforts have been made on developing new irrigants and/or establishing new irrigation protocols to facilitate eradication of microbes from the root canal system. QMix (DENTSPLY Tulsa Dental, Tulsa, OK), an experimental irrigating solution consist of a mixture of bisbigunide antimicrobial agent, a polyaminocarboxylic acid, calcium_chelating agent, saline and a surfactant. It contains EDTA, CHX and a detergent.[17,18]
A mixture of tetracycline isomer, acid, and detergent (MTAD) introduced in 2003 by Torabinejad as an irrigant and chelating agent.[17]It is composed of doxycycline(3%), citric acid(4.25%), and polysorbate 80(0.5%), and can be used as a final rinse during chemomechanical debridement of the root canal system.[17,19]
MTAD is less cytotoxic than calcium hydroxide, eugenol, 5.25% NaOCl and EDTA.[20] In addition, laboratory experiments indicated that MTAD has a strong antibacterial effect. [17,19]
Thus, the purpose of this in vitro study was to evaluate the effect of these two new endodontic irrigants (QMix ,MTAD)and saline solution on the push-out bond strength of Biodentine in comparison with other conventional perforation repair materials(MTA and GIC).

Material and Methods

Freshly extracted single-rooted human teeth were collected from department of orthodontics in Mosul college of dentistry, were used and stored in 10% formalin. The crowns of all teeth were removed at 15 mm from the apex using diamond disc bur (KG Sorensen SP, Brazil), 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.[15,16] The root sections were randomly divided into 3 groups with(7) specimens for each tested material, and the following test materials were used: **group 1**: Biodentine (Septodont, Saint Maur des Foss'es, France) liquid from a single-dose container was emptied into a powder-containing capsule and mixed for 30 seconds at 4,000–4,200 rpm, **group 2**: MTA (ProRoot; DENTSPLY Tulsa Dental, Tulsa,OK) was hand mixed with sterile water at a powder to liquid ratio of 3:1 in accordance to the manufacturer's instructions, **group 3**:GIC (Medifil, PROMEDICA, Germany) also mixed according to the manufacturer's instructions. The test materials were incrementally placed into the canal spaces of the dentin slices 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 37ºC with 100% humidity. Immediately after incubation, the samples were divided into 2 subgroups (n= 7)for each test material : In the first subgroup the root slices which are filled with Biodentine (n=7), MTA (n=7), and

GIC(n=7) were immersed into QMix (Dentsply, Tulsa Dental, Tulsa, OK, USA),and the same number of root slices that are filled with the tested materials(i.e. Biodentine(n=7), MTA(n=7) and GIC (n=7) were immersed in MTAD (Dentsply Tulsa Dental) and the same was done in the saline solution(IE Ulagay, Istanbul, Turkey). 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 37ºC with 100% humidity in an incubator. The other 3subgroups(n=7)for each material were also wrapped with a wet cotton pellet placed over each test material (without any irrigation) as a control group, and allowed to set for 48 hours .

Push-Out Bond Test(PBS/D):

The push-out bond strength values were measured by using a universal testing machine (TERCO, MT, 3037, Sweden). 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 download pressure on the surface of the test material in each sample with the Instron probe moving at a constant speed of 1 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 newton. The push-out bond strength in megapascal (MPa) was calculated by dividing this force by the surface area of test material (N/2prh), where(p) is the constant 3.14,(r) is the root canal radius, and(h) is the thickness of the root dentin slice in millimeters. [16]

Mode of Failures:

The nature of the bond failure was assessed under a stereomicroscope (Motic,Taiwan)at 20X_magnification. Each sample was categorized into 1 of the 3 failure modes: adhesive failure at test material and dentin interface, cohesive failure within test material, or mixed failure in both adhesive and cohesive failures(Fig.1).[9] All samples were then stored at 37ºC and 100% humidity for one week. Data were analyzed by using one ways analysis of variance and Duncan' s multiple range tests. The level of statistical significance was set at 0.05.

RESULTS

Push-out Test

Table(1) shows the mean values and standard deviations of the
push-out bond strength (MPa) and the distribution of failures of all
groups. The lowest push-out bond strength was observed in the MTA
group ($P < 0.05$). Biodentine displayed a significantly higher resistance
to displacement than the MTA group, whereas the mean push-out bond
strength value was significantly lower than that observed in the GIC group ($P < 0.05$) . The mean values of push-out bond strength (MPa) for the subgroups of each test material are shown in Table 2. Exposure to QMix, MTAD, and saline solutions did not affect the resistance to displacement of the Biodentine and GIC groups($P > 0.05$). MTA lost some of the strength after exposure to QMix and MTAD solutions, and the bond strength of the QMix and MTAD-treated MTA group was the lowest, but the difference was not significant($p>0.05$).
The percentages of the failure modes of the samples are presented in Table(1). The contact with the irrigant solutions did not have a significant effect on the failure modes of the tested materials as shown in table(2).

DISCUSSION

Repair materials for perforations could be subjected to displacement
forces on condensation of restorative materials. With amalgam, the condensation pressure could reach up to a maximum of 9.17 _3.04 MPa with a small and 5.5_1.8 MPa with a large amalgam plugger.[21, 22,23] Such pressure could threaten the retention of perforation

treatment materials(like MTA and Biodentine).[24,25,26,27,28] Thus, the aim of the present study was to assess the effect of a new root canal irrigants on the retention characteristics of Biodentine, MTA and GIC and whether contact with these irrigants could affect the nature of failure modes of the test materials to dentine.

In the present study, Biodentine resisted dislodgement more efficiently than MTA. However, on exposure to QMix and MTAD solutions, the dislodgment resistance of MTA was not significantly reduced, whereas Biodentine and GIC (were not affected) . Different calcium silicate–based materials could show differences in the push-out bond strength.[24,29]

After repair of the furcal perforation, the success of the endodontic therapy depends on a well-placed coronal restoration as well as the resistance of the repair material to displacement forces happening while undergoing condensation of permanent restorative materials. The amalgam condensation force with a small and large amalgam pluggers, could lead to the dislodgement of the furcal repair materials.[26,27] Thus, the bond strength of the perforation repair materials is an important factor in clinical practice.

To assess the bond strength, the push-out bond test has been shown to be efficient, practical, and reliable.[30] This study is to evaluate the push-out bond strength between Biodentine, a calcium silicate–based material, compared with other repair materials before and after exposure to endodontic irrigants solutions.

The results of our study indicated that GIC and Biodentine showed greater push-out bond strength than MTA. This result was in consistent with another study conducted by Guneser et al.(2013).[24] QMix contain EDTA, CHX and a detergent.[17,18]Exposure to 2% CHX, even though it is not an acid, may result in a reduced surface hardness ,[30,33] a decreased sealing ability, a slower setting time [3, 24], and a lower resistance to dislodgement forces. [30, 24]. Under the conditions of our study, we observed that immersing MTA in QMix after 10 minutes of setting resulted in a statistically not significant decreased push-out bond strength (ie, from 3.74 to 2.80 and 2.84 MPa respectively). In a study conducted by Hong et al [28], he showed that 2%CHX reduced the push-out strength of accelerated MTA. Nandini et al[31] showed that 2% CHX decreased the surface hardness of set white MTA significantly and suggested that CHX irrigation within 24 hours of placement of white MTA should be avoided.. On the contrary, CHX could not affect the PBS of Biodentine as it could on the MTA.[24] Saline-treated samples were not affected. This result was not in accordance with another reports in which it has been observed that saline-treated MTA samples resisted dislodgement more efficiently than the MTA control group.[(21,24].Although root canal irrigants might have an effect on the higher push-out bond strength values of MTA as it has been reported previously [3, 21, 27,24],this effect was not statistically significant in our study.

We observed the bond failures in all MTA groups predominantly at the MTA-dentin interface (adhesive type). This finding was in agreement with previous studies, [4, 27, 29, 31] that reported that MTA-dentin bond failures were usually adhesive. The adhesive mode of failure may be caused by the short storage time before the evaluation of the bond strength, which was 2 days in the present study and 3 and 7 days in the studies performed by Saghiri et al [25] and Vander weele et al. [16] While all Biodentine samples revealed a cohesive bond failure. The different failure types of MTA and Biodentine may be explained by the particle size of these materials, which affects the penetration of cement into dentinal tubules. A smaller particle size and uniform components might have a role in better interlocking of Biodentine with the dentin, which finally causes cohesive failure inside the cement. The adhesion of Biodentine to dentinal tubules may also result from the tag-like structures within the dentinal tubules leading to micromechanical anchor.[24,32] Biodentine was more resistant to dislodgement forces than MTA in the present study. The biomineralization ability of Biodentine, most likely through the formation of tags, may be the reason of the dislodgement resistance.[30,33] Han and Okiji[9] showed that calcium and siliconion uptake into dentin leading the formation of tag-like structures in Biodentine was higher than MTA. Biodentine also displayed a remarkably consistent performance even after exposure to QMix, MTAD and saline solutions. 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.

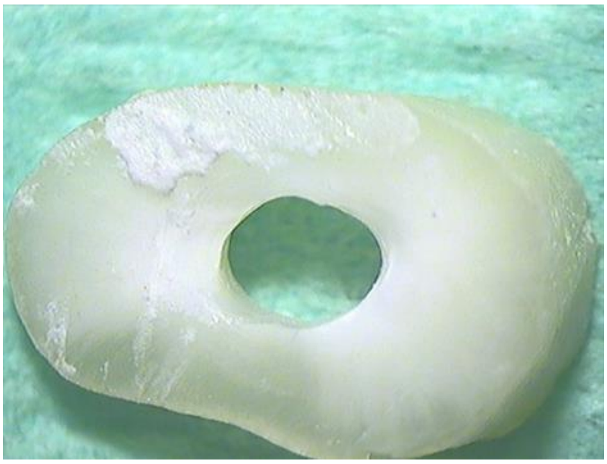
CONCLUSION

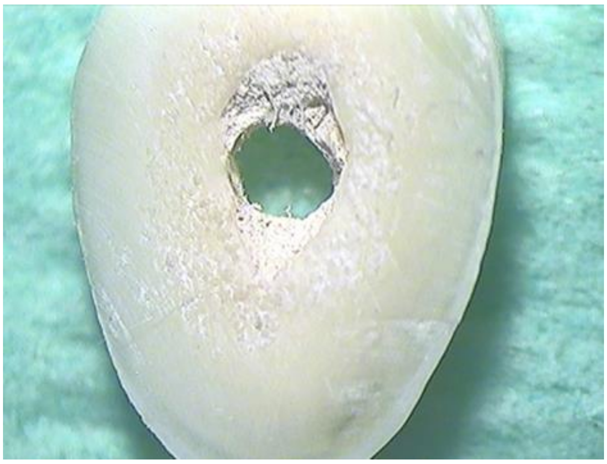
Based on this in vitro study, it can be concluded that:

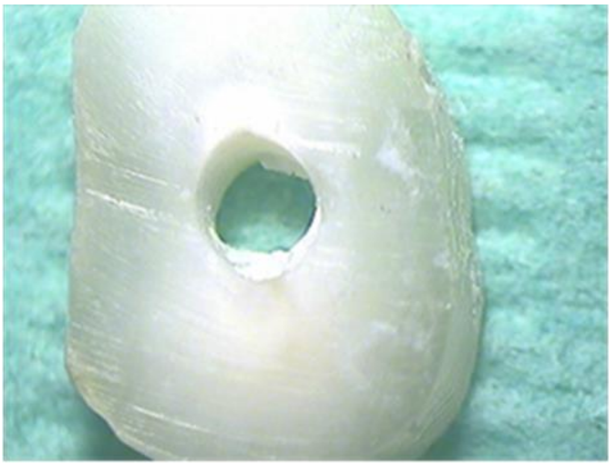
1. The force needed for the dislodgement of Biodentine from root dentin was significantly higher than MTA but less than GIC.
2. Endodontic irrigants did not influence the resistance to the dislodgement and mode of failure of any of the tested materials.

Figure (1): Inspection of the samples under a stereomicroscope at 20_ magnification and various failure modes of Biodentine samples. (A) Adhesive failure; note the clean canal wall. (B) Cohesive failure within Biodentine. (C) Mixed failure; there are remnants of Biodentine inside the canal.

(A)







(B)

(C)

TABLE 1. Mean push-out bond strength values with standard deviations and failure modes of each tested material(before exposure to the irrigant solutions).

GROUPS	Number	Mean(MPa)	SD	Failure mode % (A/C/M)*
Biodentine	**7**	**7.77^{b**}**	**0.66**	**4/92/4**
MTA	**7**	**3.74^{c}**	**0.57**	**74/20/6**
GIC	**7**	**9.77^{a}**	**1.19**	**0/100/0**

***A**, adhesive failure along the material-dentin interface; **C**, cohesive failure within the material; **M**, mixed failure.
**Different superscript letters identify significantly different groups(p<0.05).

TABLE 2. Mean push-out bond strength values and standard deviations of all test groups(after exposure to the irrigant solutions).

Group	Subgroup	Number	Mean(MPa)	SD	Failure modes % A/C/M
Biodentine	**QMix**	**7**	**7.76^{a}**	**0.64**	**5/93/2**
	MTAD	**7**	**7.70^{a}**	**0.58**	
	Saline	**7**	**7.70^{a}**	**0.61**	
	Control	**7**	**7.77^{a}**	**0.66**	
MTA	**QMix**	**7**	**2.80^{b}**	**0.87**	**71/20/9**
	MTAD	**7**	**2.84^{b}**	**0.90**	
	Saline	**7**	**3.40^{a}**	**1.66**	
	Control	**7**	**3.03^{a}**	**1.56**	
GIC	**NaOCl**	**7**	**09.15^{b}**	**1.17**	**0/100/0**
	CHX	**7**	**09.98^{a}**	**1.18**	
	Saline	**7**	**10.02^{a}**	**1.83**	
	Control	**7**	**09.77^{b}**	**1.19**	

*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)

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