Original Article

Effect of different types of chemical irrigants on the pushout bond strength of Biodentine and MTA; an in vitro study

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Abstract

60 extracted single rooted premolar human teeth were used in this study. The canal spaces of all the teeth were prepared with a round bur (1.3mm diameter). The specimens were sectioned horizontally at the mid root level dentin into 1.5±0.2 mm thick slices. The slices were randomly divided into 2 groups (n=30), group 1- Biodentine and group 2- MTA. The samples were wrapped in wet gauze, placed in an incubator, and were allowed to set for 10 min at 37°C with 100% humidity. After incubation, the samples in each group were divided into 5 subgroups to be immersed into irrigants (NAOCL, MTAD, QMIX, SMEAR CLEAR AND SALINE). After 30 min of immersion, all samples of Group 1 and Group 2 were removed from the test solutions, rinsed with distilled water, and allowed to set for 48 h at 37°C with 100% humidity in an incubator. The push out bond strength values were measured by using a universal testing machine. One-way Analysis of Variance (ANOVA), Post hoc Tukey test and independent test were used for statistical analysis in the present study. Biodentine showed greater pushout bond strength than MTA. Among the irrigants saline showed the highest pushout bond strength followed by NAOCL>MTAD>smear clear>Qmix.

Keywords: irrigants, MTA, biodentine, pushout bond strength.

INTRODUCTION

The success of endodontic treatment is based on the removal of micro-organisms from the root canal system and prevention of developing reinfection[1]. The most important aspect for endodontic treatment is proper cleaning and shaping of the root canal system[2]. Root canal irrigants are required for bacterial reduction and elimination of organic tissue remnants [3]. As the smear layer consists of both organic and inorganic components, it cannot be removed by a single irrigating agent. Hence, for this reason, it is recommended to use organic and inorganic irrigating agents together. A large number of chemical irrigants, like organic acids and chelating agents, are used to remove the smear layer [4].

Sodium hypochlorite (NaOCl) is the most commonly used endodontic irrigant and is used in concentrations of 0.5% to 6.0%[5]. It has two advantages:pulpal dissolution and antimicrobial effect.

MTAD was introduced by Torabinejad and Johnson at the Loma Linda University in 2003, which is an aqueous solution of 3% doxycycline, a broad-spectrum antibiotic; 4.25% citric acid, a demineralizing agent; and 0.5% polysorbate 80 detergent (Tween 80). In this, doxycycline is used instead of its free-base doxycycline monohydrate, so as to increase the water solubility. It is available as a 2-part mixture (Biopure MTAD; Dentsply). It has the ability to remove the smear layer in root canals as well as has an antibacterial action and has the capability to solubilize pulp tissue, especially when used after sodium hypochlorite [5]. The revised protocol for clinical use of MTAD advises an initial irrigation for 20 min with 1.3% NaOCl, followed by a 5-min final rinse with MTAD [6].

As an alternative to the recommended irrigation protocol (NaOCl + 17% EDTA as final irrigant), QMix was introduced for the dual effect of smear layer removal. This comprises of polyaminocarboxylic acid chelating agent, bisbiguanide antimicrobial agent (2% CHX), surfactant and deionized water. QMix has shown to have higher antimicrobial property against Enterococcus

faecalis as compared to CHX and found similar to EDTA in removing the smear layer[7].

Smear Clear® (SybronEndo, Orange, CA, USA) is a recently introduced chelating agent that contains 17% EDTA solution, cetrimide, and two additional surfactants (polyoxyethylene and isooctylcyclohexyl)[8]. A study by Dua and Uppin[9] showed that final irrigation with either 17% EDTA solution or Smear Clear followed by 1% sodium hypochlorite (NaOCl) was effective in removing the smear layer in coronal and middle thirds. Smear Clear removed smear layer more effectively when compared with 17% EDTA solution in the apical third.

Mineral Trioxide Aggregate (MTA) was introduced by Mohmoud Taorabinejad at Loma Linda University, California, USA in 1993. MTA is available in two types gray and white MTA. Scanning electron microscopy (SEM) and electron probe microanalysis found the differences between GMTA and WMTA and there was major difference between GMTA and WMTA is in the concentrations of Al_2O_3, MgO and FeO. Immediately after mixing MTA has a pH of 10.2 and after 3 hours of setting the pH increases to 12.5[10].

Biodentine (Septodont, Saint Maur des Fosses, France) is a tricalcium silicate developed by Septodont's research group which exhibits superior mechanical properties besides biocompatibility and bioactivity. It is used as a dentin substitute. Biodentine has a short setting time of around 12 minutes when compared with MTA, which takes 3 to 4 hours to set[11].

Push-out test is a test which is used to measure the interfacial shear strength between different surfaces. It gives us the information regarding the adhesive property of the material tested and helps to understand the resistance of the tested material to dislodgement, that is how well the material can bind to the tooth structure.

MATERIALS AND METHOD

60 extracted human single rooted premolars were used for the study. The teeth were stored in 0.2 % Thymol for 24 hours for disinfection, then stored in distilled water until use. The canal spaces of all the teeth were prepared with a round bur (1.3 mm diameter). The specimens were sectioned horizontally at the mid-root level dentin into 1.5±0.2 mm thick slices. The slices were randomly divided into 2 groups (n=30). Group 1: Biodentine liquid from a single-dose container was mixed as per manufacturer's instructions.

Group 2: MTA was mixed with sterile water at a powder to liquid ratio of 3:1 as per manufacturer's instructions.

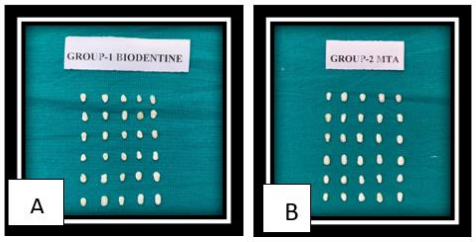

Figure 1: A: Group1-Biodentine; Group 2- MTA

The test materials were incrementally placed into the canal spaces of the dentin slices and condensed. Subsequently, the samples were wrapped in wet gauze, placed in an incubator, and were allowed to set for 10 min at 37°C with 100% humidity. The samples in each group were divided into 5 subgroups to be immersed into irrigants for 30 min i.e NAOCL, QMIX, MTAD, Smear Clear and Saline. After 30 min of immersion, all samples of Group 1 and Group 2 were removed from the test solutions, rinsed with distilled water, and allowed to set for 48 h at 37°C with 100% humidity in an incubator.

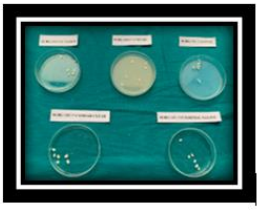

Figure 2: Samples immersed into irrigants

The push-out bond strength values were measured by using a universal testing machine. The samples were placed on an acrylic block 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 test material in each sample with probe moving at a constant speed of 1 mm/min. The maximum force applied to materials at the time of dislodgement was recorded in newtons. The push-out bond strength in megapascals (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.

Figure 3: Samples placed on UTM

The data were analysed using statistical package for social sciences version (SPSS) 22.0. The level of statistical significance was set at 95% (*P*=0.05). P-value > 0.05 was non-significant and P value < 0.05 was significant. The data of the present study were subjected to statistical analysis to interpret the differences and significance among groups. One-way Analysis of Variance (ANOVA) and independent test were used for statistical analysis in the present study.

RESULTS

There was a significant difference (p<0.05) group 1 (biodentine) and group 2 (MTA). The bond strength value of biodentine was significantly higher than MTA. Among the irrigants the pushout bond strength values of samples were highest when immersed in saline followed by NAOCL > MTAD > Smear clear > Qmix.

		SALINE	NAOCL	MTAD	SMEAR CLEAR	Q MIX	P-VALUE
MTA	MEAN	1.6933	1.3600	1.1367	1.0437	.7900	0.000
	SD	.18522	.16297	.22967	.06865	.16565	
BIODENTINE	MEAN	2.6933	1.6550	1.4533	1.1967	1.1133	0.000
	SD	.44464	.19097	.19896	.11843	.22958	
P-VALUE		0.000	0.016	0.029	0.021	0.019	

Table 1- Mean values of push-out bond strength (MPa) using **ANOVA** for the intragroup comparison in the two groups. **Independent test** is used to compare between the two groups.

DISCUSSION

Calcium silicate-based materials have gained popularity in recent years because of their resemblance to mineral trioxide aggregate (MTA) and their applicability in cases where MTA is indicated. "Biodentine" calcium silicate-based product became commercially available in 2009 (Septodont) and was designed as a "dentine replacement" material. These materials have a wide range of applications like endodontic repair (root perforations, apexification, resorptive lesions, and retrograde filling material in endodontic surgery) and pulp capping. Over the past two decades, MTA has become one of the most widely used endodontic materials. The trioxide aggregate in MTA consists of calcium, aluminium and selenium. MTA has many properties like biocompatibility, bioactivity, hydrophilicity, radiopacity, sealing ability and low solubility. It promotes the formation of new cementum in peri radicular tissues.

Irrigation is an essential step during and after instrumentation for effective smear layer removal and lubrication of the canal. It allows better penetration of the root canal sealers into the dentinal tubule openings, having an intimate adaptation of the obturating materials with the prepared canal walls. A wide range of endodontic irrigants are being used like NAOCL, EDTA, CHX, HEDP. However, new irrigants have been introduced for use in endodontics like MTAD, QMIX, SMEAR CLEAR and TETRA CLEAN.

The study showed greater pushout bond strength values of Biodentine than MTA which is in accordance with the study by Guneser et al[12]and this could be attributed to the ability of Biodentine to form tag like structures which increased the resistance to the dislodgement forces in that study as well. The biomineralization capacity of Biodentine and higher uptake of calcium and silicon ions into dentin compared with MTA could explain the higher bond strength of Biodentine to root dentine[12][13].

In our study **Saline**-treated MTA and Biodentine samples resisted dislodgement more efficiently than the other groups ($p<0.05$)

In contrast to our study, a study done by Sahebi et al[14]showed saline-treated samples resisted dislodgment forces nearly equivalent to other irrigants (NAOCL, CHX). In a study by Maha M Yahya[15], saline treated samples were not affected which was not in agreement with our study.

Hypochlorite samples resisted dislodgement forces which is in accordance with study done by Singh et al[16]which showed that NaOCl has an effect on the higher push-out bond strength values of MTA and Biodentine. Hong et al[18]showed that NaOCl-treated accelerated MTA groups showed significantly higher push-out bond strength than CHX-treated groups. However, in a study by Sahebi et al.[14], Hypochlorite-treated samples resisted dislodgement forces just as in other groups (CHX, SALINE).

MTAD resisted dislodgment forces less than saline and NAOCL but greater than smear clear and Qmix. The results were in agreement with the study by Maha M Yahya[15]. According to Garcia-Godoy et al[18]both MTAD and EDTA caused a collapse of the dentin matrix structure impeding sealer infiltration and the formation of a highly qualified hybrid layer bonding. This might be explained by the highly acidic structure of MTAD (pH 2.15) compared with 17% EDTA, which has a pH of 7.4.

Smear clear showed lower bond strength value compared with the other irrigants used which was in accordance with the previous study by Sadegh et al[19].

QMix contain EDTA, CHX and a detergent[20]. 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[12,21]. Under the conditions of our study we found that immersing MTA in Qmix for 30 minutes resulted in statistically significant decreased pushout bond strength. In a study conducted by Hong et al[17], he showed that 2%CHX reduced the push-out strength of accelerated MTA.

CONCLUSION

Biodentine showed greater pushout bond strength than MTA. Among the irrigants saline showed the highest pushout bond strength followed by NAOCL >MTAD >Smear clear >Qmix.

Within the limitations of the study, it can be concluded that Biodentine resisted dislodgement forces better than MTA. Among irrigants saline had greater bond strength values than the other irrigants. Further studies are needed for MTAD, Smear clear, Qmix as very less studies have been conducted till date

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