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Comparative evaluation of effect of q mix on the push out bond strength of epoxy resin based sealer: An in vitro study

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Abstract

Aim: The aim of this study is to evaluate the in-vitro effect of three different final irrigating solutions on the push out bond strength of AH Plus sealer.

Materials and Methods: Forty single rooted maxillary canines were collected. After standardisation of canal length all the specimens were enlarged using Protaper nickel-titanium rotary instruments to size #F3 at the working length. All teeth were randomly divided into four groups based on the final irrigation regimen as: Group1 QMix (n=10), Group 2 MTAD (n=10), Group 3 Tubulicid-Plus (n=10) and Group 4 saline (n=10). Later samples are Obturated with gutta-percha and AH-plus sealer. 2mm thick transverse sections are obtained from each tooth. Selected sections are subjected to push out bond strength testing using the universal testing machine at a constant speed of 0.5mm/min applied apico coronally.

Results: The data was subjected to statistical analysis by one way ANOVA and pair wise comparison by Newman-Keuls multiple posthoc procedures. Among all the groups QMix showed highest bond strength

Conclusion: Within the limitations of the study, the maximum push out bond strength of sealer is seen in the specimens irrigated with QMix than remaining final irrigating solutions.

Keywords: Irrigating solutions, MTAD, Push out bond strength, QMix.

Introduction

Various factors determine the success of endodontic treatment which includes thorough shaping, cleaning and three dimensional sealing of the root canal system. [1]

Ability of mechanical instrumentation alone to clean and eliminate debris is limited. Peters *et al* reported whatever may be the instrumentation technique certain walls of root canal remain untouched during cleaning and shaping. [2]

Anatomical areas like lateral canals, isthmuses, and deltas remain uninstrumented. Hence Irrigation plays critical role in success of root canal treatment by eliminating debris and microorganisms from such areas.[3]

Sodium hypochlorite is used as most commonly used irrigating solutions in endodontics due to its antimicrobial action and its ability to dissolve necrotic tissue. However,

it is ineffective in removing inorganic portion of the smear layer. [4]

For smear layer removal various chelating agents like ethylenediaminetetraacetic acid (EDTA), Citric acids, Phosphoric acid, EDTAC and Carbamide Peroxide have been used. [5]

Combined use of NaOCl and EDTA represents the common irrigation protocol. However, combination of NaOCL and EDTA results in reduction of free chlorine content in NaOCL[6] and furthermore this combination results in loss of structural integrity of dentin. [7]

In a quest to overcome the problems of interactions of initial and final irrigating solutions and to aim at improved smear layer removal various other new irrigating solutions like QMix MTAD, Tublicid Plus has been introduced into the market. [8]

For three dimensional obturation, using gutta-percha with various sealers is the standard protocol in root canal treatment. For effective seal, various resin based sealer materials characterized by low solubility, and high degree of stability, less polymerization shrinkage and increase penetrability have been introduced and AH-plus is one among them. [9]

The data regarding the effects of newer irrigating solutions such as QMix and its comparison with MTAD, Tublicid Plus on the bond strength of root canal sealers will help clinicians in their decision making in choosing effective final irrigating solutions.

Therefore, the aim of the present study is to evaluate the effect of different final irrigating solutions on the push out bond strength of AH plus sealer.

The null hypothesis states that the push out bond strengths (Mpa) of teeth treated with different irrigating solutions is not significantly different.

Materials and Methodology

A total of forty freshly extracted human permanent single rooted maxillary central incisors that were free of root resorption, caries, fracture or previous treatments were used in this study. All teeth were immersed in 5.25% sodium hypochlorite (NaOCl)(Vishal dentocare PVT.LTD) for 5 minutes in order to remove tissue debris. Teeth were then stored in distilled water until use.

The crowns were sectioned transversally at the cementoenamel junction. and the root length was set to 14 mm. The working length (WL) was determined by inserting a #10 K-file (Mani, Japan) into the canal up to the moment its tip was just seen in the apical foramen, then withdrawing it 1 mm.

All roots were instrumented with the crown down technique using nickel-titanium Protaper rotary files (Dentsply Maillefer, Ballaigues, Switzerland). Root canal preparation was carried out by shaping SX and S1 files in the cervical third, by S2 file in the middle third and then by F1, F2 and F3 finishing files up to the entire working length. Root canals were irrigated with 5ml of 3% NaOcl (Vishal dentocare PVT.LTD) in between instrumentation. After root canal preparation roots were stored in saline solution and finally they were divided randomly into four groups based on the final irrigating solutions.

Group I: QMix 2 in 1 (Dentsply Tulsa Dental Specialities, Tulsa, OK)

Group II: Bio pure MTAD (Dentsply Tulsa Dental, Tulsa, OK)

Group III: Tublicid Plus (Dental Therapeutics AB, Sweden)

Group IV: Saline (Claris life sciences Ltd, India)

Root canals irrigated with a 30-g side-vented irrigation probe (Canal Clean, Biodent Co. Ltd, South Korea) and a syringe and Final irrigation is done according to the manufacturer's instructions.

Group-1: 5ml of Qmix 2 in 1 solution was taken in an irrigating syringe and placed passively in the root canal with the tip 1-2mm short of the working length and irrigated for 90 seconds .

Group-2: 5ml Biopure MTAD was taken in an irrigating syringe which was placed passively with their tip 1-2mm short of the working length. 1ml of this solution was placed in the canal for 5min and then the canal was flushed with remaining 4ml of MTAD solution.

Group-3: 5ml of Tubulicid-plus was taken and irrigated for 20 seconds and later dried with paper points. Filled the canal again with Tubulicid-plus and rinsed with distilled water.

Group-4: The canal was flushed with 5ml of normal saline. Which was taken in an irrigating syringe and placed passively in the root canal with the tip 1-2mm short of the working length and irrigated.

All the teeth were dried using corresponding Pro taper paper points (Dentsply Maillefer, Ballaigues, Switzerland). The teeth were obturated using F3 Protaper gutta percha cone (Dentsply-Maillefer, Ballaigues, Switzerland) and AH plus sealer (Dentrey Dentsply, Germany) using single cone technique. Teeth were stored at 37°C and 100% relative humidity for seven days to allow the sealer to set.

In each tooth three 2mm, thick dentin disks were prepared from coronal, middle and apical third using a diamond saw perpendicular to the long axis of the root and under water cooling. Selected disks were subjected to push out bond strength testing using the universal testing machine (CHYD/PTC/UTM/3) with a plunger of 0.8mm in diameter at a cross head speed of 0.5mm/min until the displacement of obturating material occurred.

The bond strength was determined using a computer software program. The bond strength was recorded in Mpa by dividing the load in Newton by the area of bonded interface using the following formula.

Bond Strength(MPa) = Load in Newton/Area of bonded surface

To calculate the area, the following equation was applied:

$A = \pi(R+r)\,[h2+(R-r)2]^{0.5}$

where π is the constant value 3.14, R is the coronal radius, r is the apical radius and h is the thickness (mm) of the specimen.

Data analysis was carried out using the Statistical Package for Social Sciences (SPSS version 21). Overall difference between groups was analyzed by the Analysis of Variance (ANOVA). Then, pair wise comparisons were performed with the Newman-Keuls Post Hoc Test. The significance level of this study was set at 0.05.

Results

A summary of the mean bond strengths of sealer to dentin for all groups irrigated with various final irrigating solutions is given in Table 1. There was a significant difference between the push out bond strengths of AH Plus sealer with respect to type the irrigation solution ($p<0.05$). The highest mean bond strength value was recorded for the QMix group (2.25 ± 0.09 Mpa), while the lowest mean bond strength value was recorded for saline (1.04 ± 0.07 Mpa). A one-way ANOVA revealed that there were high statistically significant differences in mean bond strength values of sealer irrigated with different types of final irrigating solutions ($P < 0.001$). Newman-Keuls Post Hoc inter comparisons showed highly significant differences among all pair wise groups (Table 2). Results were graphically represented comparing various groups in (figure 1).

Discussion

In root canal treatment mechanical instrumentation usually results in smear layer formation, which can be forced 1-5 um into the dentinal tubules that reduce dentine

permeability up to 78%.[10] Removal of smear layer is important for improved disinfection and sealing ability of root filling materials thereby reducing microleakage. [11]

For effective removal of smear layer various irrigating solutions such as NaOCl, EDTA, HEBP, Tetraclean, MTAD, Maleic acid, Triclosan, Gantrez, QMix etc were introduced in endodontics for various purposes such as tissue dissolving, antimicrobial and chelating properties. [12]

Along with proper irrigation, adhesion of root canal filling material to dentinal wall is important in static situations to eliminate any spaces to prevent percolation of fluids between filling material and radicular dentine. [13] In dynamic situations to resist dislodgement of filling during subsequent manipulations. [14]

Various testing methods have been introduced in endodontics to determine the effectiveness of adhesion between the filling material and radicular dentine such as tensile, shear, push out etc. [15] Push out bond strength test has advantage of evaluating the materials even if their bond strength is low. [16]

So, in the present study push-out bond strength test of obturating material in four different final irrigating solutions groups were evaluated. Among them, QMix showed better performance compared to others.

QMix is a new root canal irrigating solution and it contains a mixture of a bisbiguanide antimicrobial agent, a polyaminocarboxylicacid calcium-chelating agent, saline and a surfactant. [17] The highest pushout bond strength of 2.25Mpa seen in this group. This may be due to its effective smear layer removal ability thereby providing good sealer penetration and high bondstrength when compared to others. This is supported by study done by Sayesh Vemuri et al[8] and Ballal et al [18] Who showed QMix has better smear layer removing ability than EDTA and MTAD and AH Plus sealer has greater wettability and penetrating ability on root canal dentin irrigated with QMix due to low contact angle respectively.

Next higher pushout values were reported by BioPure MTAD Which is a mixture of Tetracycline isomer (3% doxycycline), 4.25% citric acid, detergent (0.5% polysorbate 80). It has smear layer removal and antimicrobial properties. [19] Greater smearlayer removal ability is attributed to its low surface tension value of 34.5 mJ/m^2 resulting in intimate contact of irrigant solutions with the dentinal walls. [20] MTAD has ability to preserve more collagen than other irrigating solutions resulting in higher pushout bondstrength.[21]

In the present study, Tubulicid Plus showed the least bond strength (1.44Mpa) among the three experimental groups. least bond strength with tubulicid plus may be due to its inferior smear layer removing ability than MTAD and QMix. [22]

Apart from the effect of irrigating solutions, the chemical and physical properties of sealer also influence the depth of penetration there by affecting the bond strength. [23] In this study AH PLUS sealer was used for its good handling characteristics, better wettability and bondstrength. [24,25]

Thus this study shows that high bond strength of the obturating material in the radicular dentine depends on final irrigating solutions. This was observed in samples treated with QMix.

Conclusion

Within the limitations of this study,

1. Final irrigation with QMIX, MTAD, Tubulicid-Plus has influence on the bond strength of AH Plus sealer.
2. Maximum pushout bond strength was observed with QMIX, whereas minimum pushout bond strength was observed with Tubulicid Plus.

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Legends Table

Table 1: Overall comparison of different final irrigating solutions with respect to their pushout bond strengths (Mpa).

Groups	N	Mean ± SD	Standard Error	F and p value
QMIX	10	2.25 ± 0.09	0.03	
MTAD	10	1.71 ± 0.06	0.02	F = 478.46
Tublicid Plus	10	1.44 ± 0.06	0.02	P = <0.001*
Saline	10	1.04 ± 0.07	0.02	

ANOVA Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

Table 2: Post Hoc comparisons of different irrigating solutions with respect to their pushout bond strengths (Mpa)

Groups		Mean Difference	P Value
QMIX	MTAD	0.54	<0.001*
	Tublicid Plus	0.81	<0.001*
	Saline	1.21	0.002*
MTAD	Tublicid Plus	0.27	<0.001*
	Saline	0.67	<0.001*
Tublicid Plus	Saline	0.40	<0.001*

Newman-Keuls Post Hoc Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

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