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Comparative assessment of various root canal sealer for failure mode after obturation; An in vitro study

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ABSTRACT

Success of root canal treatment depends upon five major steps. Among them, biomechanical preparation is most important. Root canal system shows various anatomical variations. These variations will help microorganism to harbour themselves. In order to disinfect the root canal, various irrigating solutions are used. These chemical solutions may change the surface characteristics of root dentin. Hence, this study was carried out with an aim- to determine the failure mode of sealer after obturation using the various irrigating solution. The study was carried out using 40 extracted premolars. Biomechanical preparation was done using the crown down technique. Various irrigating solutions, namely, 5.25% sodium hypochlorite. 2% chlorhexidine gluconate, QMIX 2 in 1, 17% EDTA liquid were used for irrigation. Later obturation was done using AH plus sealer and cold condensation technique. A section of 5mm root was obtained at the middle one third. Push out bond strength was evaluated and the mode of failure of the sealer was noted. The maximum number of mixed failure mode (n=7) in Qmix 2 in 1 as well as in 2% CHX. Similarly, in 5.25% NaOCl, 8 samples showed Mixed failure mode. However, in 17% EDTA, the equal number of the sample had Adhesive and Mixed type of failure mode (n=5). Use of EDTA + CHX or QMix during final irrigation significantly improved sealer penetratin resulting in impervious seal to the obturation. Thus contributing to the success of endodontic treatment.

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INTRODUCTION

Sealers play an important role because it wedges inside the dentinal tubule (Singh *et al.*, 2015). It is rightly been said that instruments lead to shaping and irrigants lead to cleaning (Nikhade *et al.*, 2016). The requirements of root canal irrigants include biocompatibility, stability in solution form and it should work in the presence of blood and serum. It should also possess antimicrobial property (Khandelwal and Ballal, 2016).

QMIX 2 in1 irrigating solution is used in the present study because it has both smear layer removal and antimicrobial property (Salz *et al.*, 2009). Smear layer penetrates to a depth of 40 um inside denti-

nal tubules. The smear layer hinders the penetration of disinfecting solution. It also harbors bacteria (Zehnder, 2006). Therefore, its removal is imperative. Commonly used chelating agents such as EDTA removes the smear layer but has no disinfecting property. Therefore, a single premixed solution having both smear layer dissolving and antimicrobial property is used. QMIX 2 in1 irrigating solution has a detergent, chelating agent, and antimicrobial agent (Chaudhry *et al.*, 2017). Detergent (Tween 80) reduces the surface tension, thus allows increased penetrability, chelator removes the smear layer and chlorhexidine disinfects the canal. Thus single irrigant will impart all the required properties (Vanapatla Amulya *et al.*, 2013).

In the present study, 2% CHX is used. Chlorhexidine gluconate is a "biguanide in a base containing water, 11.6% alcohol, glycerin, PEG-40 sorbitan diisostearate, flavor, sodium saccharin, and FD&C Blue No.1 (Pattanaik and Chandak, 2013). It is the most commonly used irrigant for final irrigation because of its antimicrobial property. It adsorbs on the surface of root canal walls, thus increasing disinfection but reduces the sealer penetration.

"Sodium hypochlorite is the primary root canal disinfectant." It is highly efficient and widely accepted. It is a nonspecific proteolytic agent (Kolanu *et al.*, 2016). "It was first introduced during World War I in 1915 by Henry Dakin" (Willson, 1935). The action of hypochlorite is increased by increasing the temperature (up to 65 degrees) and concentration (up to 6%) of the solution (Estrela *et al.*, 2002).

EDTA is an aggressive chelator. The most common concentration of EDTA used is 17%. EDTA leads to erosion of the walls of dentin. Liquid EDTA is more penetrable as compared to EDTA gel. Therefore, 17 %EDTA liquid is used in the current study to evaluate its effect on the adhesion of sealer at the dentin-core filling material interface.

"AH, Plus Sealer is an epoxy resin based sealer (Lopes *et al.*, 2012). It consists of epoxide paste and amine paste. Epoxide paste consists of Diepoxide, Calcium tungstate, Zirconium oxide, Aerosil Pigment. Amine paste consists of 1-adamantane amine, N'-dibenzyl-5-oxa-nonandiamine-1,9TCD-Diamine, Calcium tungstate, Zirconium oxide, Aerosil, Silicone oil."

Hence the present study was aimed to determine the failure mode of various root canal sealer.

MATERIALS AND METHODS

Preparation of Samples

Extracted Maxillary and Mandibular Premolars were taken for this study(40 TEETH). All teeth were of orthodontic cases. Teeth were cleaned thoroughly and stored in 0.1% thymol until use.OSHA guidelines were followed during the management of extracted teeth (Lee *et al.*, 2007).

Crown was removed at CE junction. The working length was assessed using a 15 K file. Crown down technique was used for Biomechanical preparation using Endomotor (Dentsply X-smart) and rotary ProTaper file system up to the size F2. Canals were enflamed enough to accomadate the irrigants. Canals were blocked at the apex by sticky wax to block the flow of irrigants from the canal. This step was done to generate the clinical scenario. First Irrigation was done using 5.25% sodium hypochlorite and 17% EDTA liquid. Saline was used as an intermitant irrigating solution. The teeth were then randomly devided into four groups according to irrigation.

GROUP I- 5.25% sodium hypochlorite.

GROUP II- 2% chlorhexidine gluconate.

GROUP III- QMIX 2in1.

GROUP IV- 17% EDTA liquid.

Irrigation Protocol Followed was,

1. 5.25% NaOCl to dissolve the organic components, followed by saline
2. 17 % EDTA to eliminate the smear layer
3. After this, saline was used and the final irrigation protocol was followed as per the groups made"

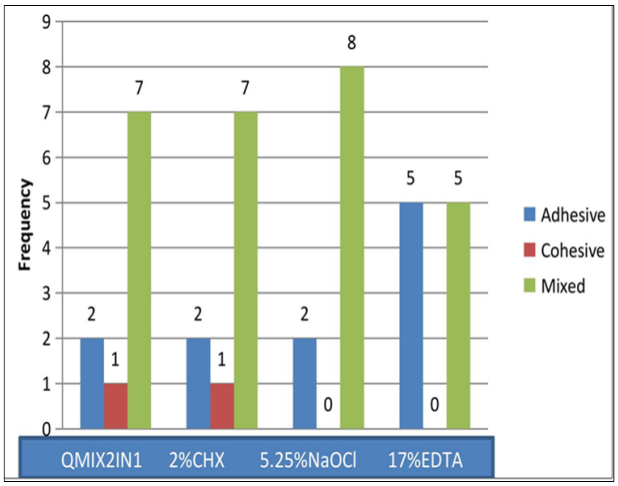
Canals were then obturated using "AH Plus sealer and gutta percha points (Dentsply Maillefer)". A 5 mm section was obtained by doing Horizontal sectioning of the root at the middle one third. Vernier calliper is used to measure the section. Apical one third sections were not taken due to their insufficient diameter at the apex.

RESULTS AND INTERPRETATION

Table 1 illustrated a maximum number of mixed failure mode (n=7) in Qmix 2 in1as well as in 2% CHX. Similarly, in 5.25% NaOCl, 8 samples showed Mixed failure mode. However, in 17% EDTA, the equal number of the sample had Adhesive and Mixed type of failure mode (n=5). Graph 1 depicts that the predominant Mode of Failure is of Mixed type—i.e. (Both adhesive and cohesive failure).

Table 1: Comparison of failure bond in all the groups by chi-square test

Group	Total	Failure Mode			p-value
		Adhesive	Cohesive	Mixed	
QMix 2 in 1	10	2 (20%)	1(10.0%)	7(70.0%)	0.524
2% CHX	10	2 (20.0%)	1(10.0%)	7(70.0%)	
5.25% NaOCl	10	2(20.0%)	0(0.0%)	8(80.0%)	
17% EDTA	10	5(50.0%)	0(0.0%)	5(50.0%)	



Graph 1: Failure Mode Analysis

DISCUSSION

Sealing ability of root canal sealers is directly proportional to their adhesion properties. The adhesive properties are dependent on the surface tension. The wetting ability of the sealer and the cleanliness of the adhered surface are also important. The adhesion can be of two types- micromechanical or chemical. For chemical adhesion, smooth adherend is required, while for the micromechanical adhesion roughening of the adherend is required (Teixeira *et al.*, 2009). "Adhesion of root canal sealer is imperative in both dynamic situations (when dislodgement forces are applied) and static situations (to eliminate any space that allows the percolation of fluids between the filling and the wall)" (Teixeira *et al.*, 2009). Adhesion of the sealer can be enhanced by pretreating the surface of the dentin. Surface treatment with different irrigation regime changes the chemical composition of surface dentin.

Authors favoring the removal of smear layer are Pashley 1984, Kouvaset al.1998. Authors suggesting retention of smear layer are "Galvan et al. 1994, Michelich et al. 1980, Drake et al. 1994."

According to this authors smear layer reduces dentin permeability for bacterial and thus reducing their colonization (Arunagiri *et al.*, 2015; Patni *et al.*, 2016)

Adhesive failure indicates that the fracture or dislodgement is between the dentinal wall and filling material.

i.e. the sealer. Cohesive failure indicates the separation at the sealer- gutta percha interface. Mixed failure indicates separation at sealer-dentin and sealer-gutta percha interface.

Jainaen *et al.* (2007) studied the POBS in the absence and presence of the main core. They conducted their study on extracted teeth. Teeth were instrumented. The smear layer was removed. Canals were obturated. Push out bond strength was measured. Stereomicroscopy was done. Failure modes were analysed. The study results showed that bond strength was much higher when the sealer alone filled the canal space. This is because a thick layer of sealer is comparable to the canals filled with sealer alone. Thin layers of sealer cause more shrinkage and less dimensional integrity. Moreover, expansion of AH Plus after setting cause increased sealer penetration and superior bond strength.

Nunes *et al.* (2008) studied the adhesion of different sealers. They conducted their study on extracted teeth. Teeth were instrumented. Smear layer was removed. Canals were obturated. Push out bond strength was measured. Stereomicroscopy was done. Failure modes were analyzed. The study results showed that AH Plus is better than methacrylate based sealers. This is because AH Plus has superior infiltration into the micro irregularities. This is due to AH Plus exhibit minute particle size. It has thixotropic property as well as high setting time. It will augment the mechanical interlocking between the root canal sealer and root dentin.

Ballal *et al.* (2016) studied the wettability of root canal sealers. They stated that wettability is dependent on the final irrigant used. Wettability increases when the surface tension of the irrigant decreases. The detergent content of QMIX 2in 1 reduces the surface tension, thus providing better adhesion. They also stated that "CHX has been shown to increase the surface free energy of dentine and decrease the contact angle of root canal sealers,

thereby improving the wettability of root canal sealers."

Patni *et al.* (2016) studied the Sealing capacity of Four Different Root Canal Sealers.

It was concluded that there were statistically prominent variations amongst the experimental groups. The shrinkage is associated with the setting of the sealer. Potential dissolution might hamper the adequate seal of the root canal. This leads to treatment failure. Apical seal was superior with AH Plus and Apexit root canal sealers. This is due to improved mechanical interlocking. Also, it is insoluble in oral fluids.

CONCLUSION

In this study, the failure mode analysis showed mixed failure, i.e. both adhesive and cohesive. Use of EDTA + CHX or QMix during final irrigation significantly improved sealer penetration resulting in impervious seal to the obturation. Thus contributing to the success of endodontic treatment.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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