



RESEARCH ARTICLE

EVALUATION OF THE EFFECT OF DIFFERENT IRRIGANT SOLUTIONS ON THE SMEAR LAYER REMOVAL ON ROOT CANAL DENTINE AT CORONAL, MIDDLE AND APICAL ROOT SECTIONS USING SEM STUDY

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ABSTRACT

Success in endodontic therapy depends on chemo mechanical debridement of the root canal system through the use of instruments and effective irrigant solutions which serve variety of purposes including antibacterial action, tissue dissolution, cleaning and chelating. Smear layer prevents the penetration of intracanal medicaments into dentinal tubules and influences the adaptation of filling materials to canal walls. Therefore the present study will evaluate the effect of different chemical and herbal irrigant solutions on the smear layer removal on root canal dentine. Forty single rooted human premolars were decoronated transversely at the cemento-enamel junction and the crowns were discarded. Roots were equally divided into groups according to the final irrigants used: Group 1: 17% EDTA, Group 2: Qmix, Group 3: Tea tree oil, Group 4: saline 5 % Ten root halves from each group were prepared. After standard preparation and final irrigation with the irrigants coronal, middle and apical thirds of the roots were examined for the smear removal from dentinal tubules using SEM. Data was obtained and the results were analyzed statistically.

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INTRODUCTION

Debridement of the root canal system is essential to endodontic success. Mechanical instrumentation of the root canals produces a smear layer composed of organic and inorganic substances such as dentin particles, necrotic debris, and odontoblastic processes. The smear layer is an amorphous irregular thin layer that covers the prepared canal walls and occludes the orifices of the dentinal tubules. (Shrahvaran *et al.*). Effect of smear layer on sealing ability of canal obturation: a systematic review and metaanalysis. *J Endod* 2007). It also hinders the penetration of intracanal medications and sealers into the dentinal tubules. Effective cleaning of the canal system requires the use of irrigation solutions throughout during instrumentation which serve variety of purposes including flushing of debris, antibacterial action, tissue dissolution, cleaning and chelating action to remove the smear layer (Siqueira *et al.*) bacteriologic investigation of the effects of sodium hypochlorite and chlohexidine during endodontic treatment of teeth with apical peridontitis. *Oral surg oral med oral pathol oral radiol Endod* 2007; 104: 122-30)

Methods to remove the smear layer Chelating agents

- EDTA – 17%
- Qmix- 17 %EDTA, Chlorhexidine and a detergent (Tween-80).
- MTAD- 3% doxycycline, 4.25% citric acid and a detergent (tween-80).

Organic acids

- Citric acid- 10%
- Maleic acid- 7%
- Polyacrylic acid – 40%
- Tannic acid- 25%

Herbal methods

- Melaleucaalternifolia(Tea tree oil)
- Green tea
- Triphala
- Morindacitrifolia

- Tamarindusindica

Sodium hypochlorite: Sodium Hypochlorite (NaOCl) has an extensive history in medicine and dentistry and continues to be popular even today. The ability of NaOCl to dissolve organic tissues (necrotic pulp) is well known (Rubin *et al.* 1979, Wayman *et al.*, 1979). However, its capacity to remove smear layer from the instrumented root canal walls has been found to be lacking.

Edta: It is the most common chelating solution which reacts with the calcium ions in dentine and forms soluble calcium chelates. The use of NaOCl and EDTA has been reported to be effective in removing pulpal tissue remnants and the organic and inorganic components of the smear layer (Zehnder Root canal irrigants).

Qmix: QMiX is a novel endodontic irrigant for smear layer removal with added antimicrobial action QMix contains EDTA, Chlorhexidine and a detergent (Tween-80). EDTA is a chelating agent. Chlorhexidine on the other hand is an antibacterial agent and has a high substantivity. Detergent i.e. Tween-80 is added to reduce the surface tension as it helps the irrigant to penetrate deeper and to lift up the broken particles of smear layer by its frothing action. (Stojicic *et al.*, Antibacterial and smear layer removal ability of a novel irrigant, Q Mi X. I Endod J 2012; 45: 363–37).

Melaleuca Alternifolia (Tea tree oil): Due to the deleterious effects of synthetic irrigants, it is important to look for herbal substitutes which have no deleterious effects. Tea tree oil or melaleucaalternifolia is a native Australian plant, the oil of which have many properties which favour its use in dentistry. It is an antiseptic as well as an antifungal agent. It has a mild solvent action and hence could hold potential applications in root canal treatment. M.S lajjani^{et al.} The effect of German chamomile (*Marticaria recutita* L.) extract and tea tree (*Melaleuca alternifolia* L.) oil used as irrigants on removal of smear layer: a scanning electron microscopy study. International Endodontic Journal, 2006, 39, 190–195. There is limited information available about the ability of Qmix to remove smear layer. Not enough studies have been done on the herbal root canal irrigants. Therefore the need to compare and evaluate the ability of Qmix and tea tree oil to remove smear layer when compared with EDTA.

Aim of the study: To evaluate and compare the effect of QMIX, EDTA and tea tree oil on smear layer removal of the root canal.

MATERIALS AND METHOD

Preparation of sample: 40 freshly extracted human single rooted premolars were selected. The selected teeth were cleaned of soft or hard tissues and decontaminated by immersion in 5.25% sodium hypochlorite for 30 mins and stored in normal saline solution at room temperature. The crowns of all specimens were decoronated at the cemento-enamel junction (CEJ) with doublefaced diamond disc at low speed, with water coolant, to obtain a 15 mm±0.5 mm root length. The root canals were randomly divided into equal 4 groups according to the final irrigation solutions. The working length was established by deducting 1mm from the length recorded when tips of #10 or #15 k files were visible at the apical foramen. The root canals were enlarged up to master apical file number (40 kfile) using step back technique. During instrumentation, the canals of 3 groups were recapitulated and

irrigated with 5 mL of 2.5% NaOCl and the fourth group was irrigated with 5 ml of 0.9 % normal saline (control group) and then dried with sterile paper points. After completed instrumentation final irrigation was done with 5ml of the tested solutions and dried with sterile paper points. No instrumentation was performed during the final irrigation with the test solutions. After final irrigation, each root canal was flushed and copiously irrigated with 10 ml distilled water and dried with absorbent paper point and the canals orifice were sealed with a small cotton pellet. Two longitudinal grooves were prepared on the palatal/lingual and buccal surfaces of each root using a diamond disc, avoiding penetration into root canals. Each root was then split longitudinally into two halves using a mallet and a Stainless-Steel chisel. The specimens were dehydrated and coated with gold using an ion sputter and immediately examined for SEM evaluation.

Photographs were taken at ×1000 magnification at the coronal, middle and apical third

SEM scores: The representative areas were evaluated by an independent endodontist who did not know the groups to which the samples belonged. The scoring was made as described by Rome *et al*

- Score findings
- 0 - no smear layer, all dentinal tubules open.
- 1 - minimum smear layer >50 % dentinal tubules visible
- 2 - moderate smear layer; < 50% dentinal tubules open
- 3 - heavy smear layer; outline of dentinal tubules obliterated

(Rome WJ, Doran JE, Walker WA. The effectiveness of gly-oxide and NaOCl in preventing smear layer formation. J Endodon. 1985; 11: 281-288)

- Sem photographs of root canal
- Effect of 17% EDTA on the a)coronal, b)middle and c)apical thirds of the root canal.
- The smear layer has been removed in a & b. some debris can be seen in c.

Effect of QMIX on root canal. The smear layer has been removed in a,b. Some debris can be seen in c. The effect of tea tree oil on root canal. In a,b, some smear layer is present. C is completely covered in smear layer. Effect of saline on root canal. All 3 regions are completely covered with smear layer

Statistical analysis: The data was analysed using IBM spss version 21. A descriptive analysis was computed as mean and standard deviation of the smear layer score analysed at the coronal, middle and apical thirds of the root canal for each group. Wilcoxon rank test was used to detect the difference between the tested groups.

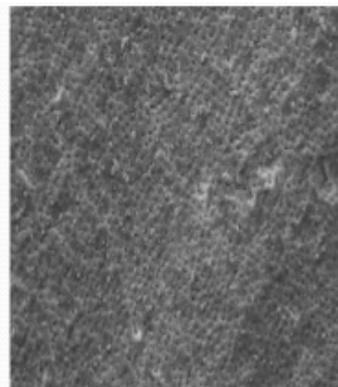
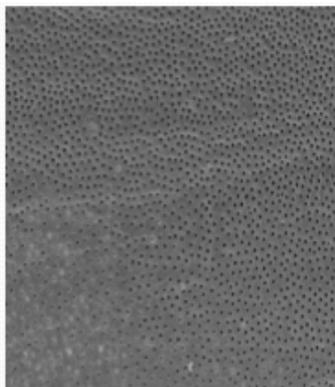
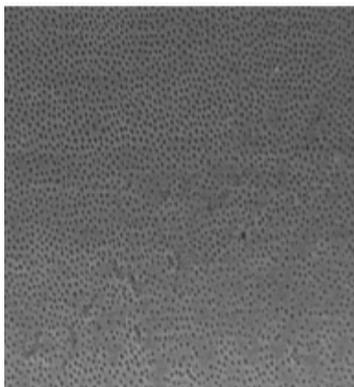
RESULTS

The scores exhibit that in all the three parts of the root canal, Qmix followed by EDTA were effective in removing smear layer and that only in the apical third, it was statistically significant. In the coronal and the middle thirds tea tree oil was a more effective than saline in removing smear layer and this was statistically significant in the coronal third. In the apical third tea tree oil was as ineffective as saline.

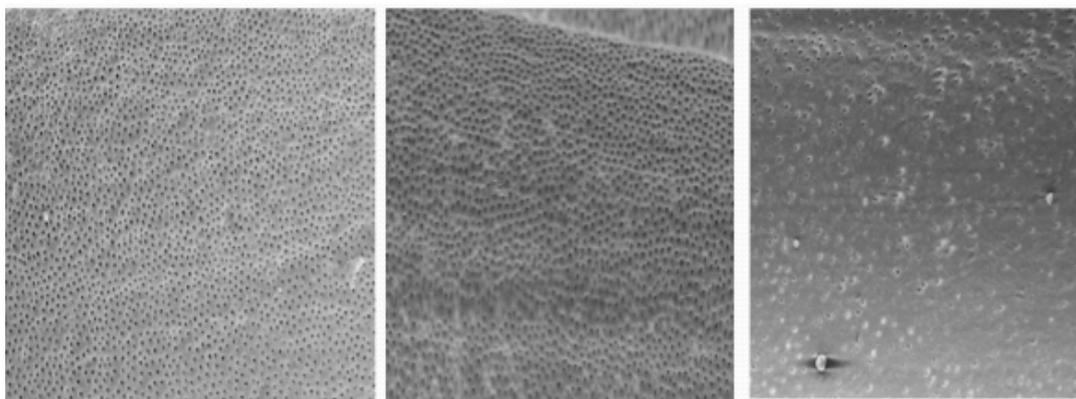
- Table 2. P values for smear layer removal among groups



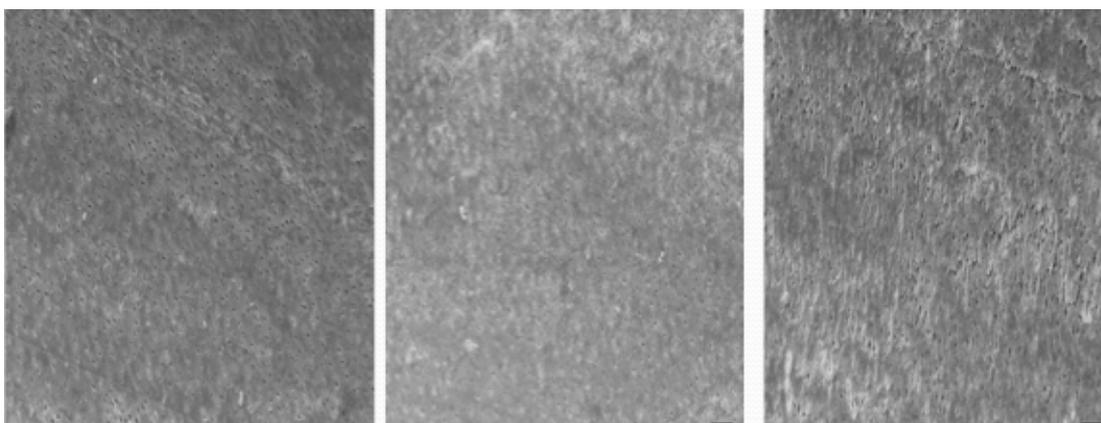
Photographs were taken at $\times 1000$ magnification at the coronal, middle and apical third



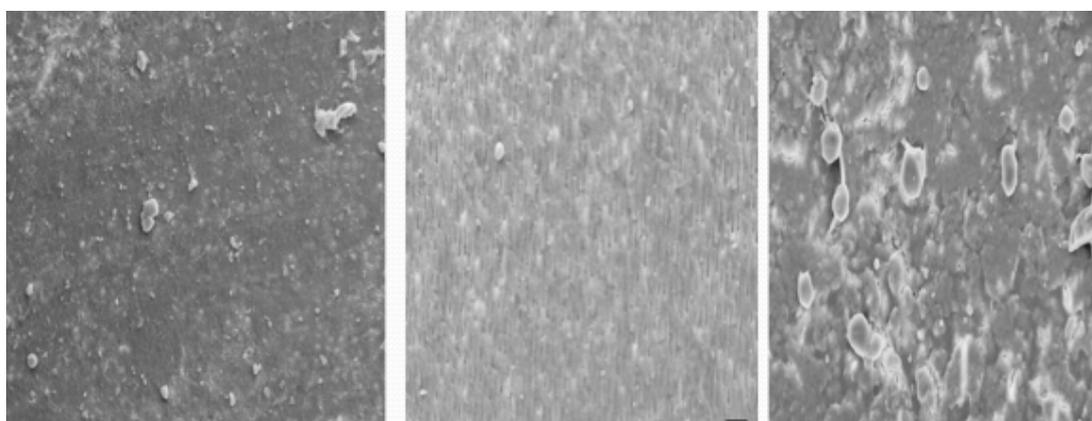
Effect of QMIX on root canal. The smear layer has been removed in a,b. Some debris can be seen in c.



The effect of tea tree oil on root canal. In a,b, some smear layer is present. C is completely covered in smear layer



Effect of saline on root canal. All 3 regions are completely covered with smear layer



Groups N=10	Coronal third	Middle third	Apical third
EDTA	0.60 ± 0.52	0.60 ± 0.52	2.0 ± 00
QMIX	0.20 ± 0.42	0.40 ± 0.52	1.2 ± 0.42
TEA TREE OIL	2.60 ± 0.51	2.80 ± 0.42	3.00±00
SALINE (CONTROL)	3.00 ± 00	3.0 ± 00	3.00 ± 00

Canal level	Group comparison	P value
Coronal	No significant difference between EDTA & QMIX	P=0.157
	Significant difference between Tea tree oil & saline	P=0.046*
	Significant difference between EDTA & saline	P=0.004*
	Significant difference between Qmix & saline	P=0.003*
	Significant difference between EDTA & tea tree oil	P=0.002*
	Significant difference between Qmix & tea tree oil	P=0.004*
Middle	No significant difference between EDTA & QMIX	P=0.414
	No significant difference between Tea tree oil & saline	P=0.157
	Significant difference between EDTA & saline	P=0.004*
	Significant difference between Qmix & saline	P=0.004*
	Significant difference between EDTA & tea tree oil	P=0.004*
	Significant difference between Qmix & tea tree oil	P=0.004*
Apical	Significant difference between EDTA & QMIX	P=0.005*
	No significant difference between Tea tree oil & saline	P=1
	Significant difference between EDTA & saline	P=0.002*
	Significant difference between Qmix & saline	P=0.003*
	Significant difference between EDTA & tea tree oil	P=0.002*
	Significant difference between Qmix & tea tree oil	P=0.003*
	P* value significant at < 0.05	

DISCUSSION

The present study revealed that saline does not remove smear layer at all. This is in accordance with studies done by other researchers. The other findings of the study is that EDTA removes smear layer effectively from the coronal and the middle thirds but its action in the apical third is impaired. This is in accordance with studies done by Prabhu *et al.* (2003). This can probably be explained by the fact that dentin in the apical third is more sclerosed and the number of dentinal tubules present there is also less. Kandil *et al.* (2014) also found that EDTA removed the smear layer efficiently in the coronal and middle thirds but only malic acid succeeded in removing it from the apical third. The present study revealed that Qmix was more effective than 17% EDTA in removing smear layer from all the three areas but it was statistically significant only in the apical third (P= 0.005). This is in contrast to a study by Dai *et al.* (2011). Dai *et al.* found that removal of smear layer by Qmix and 17% EDTA were not significantly different. Stojicic *et al.* (2012) found that Qmix removed smear layer equally well as EDTA (p = 0.18). The present study revealed that tea tree oil had only minor effects in the removal of smear layer. This was statistically significant in the coronal third only.

Studies by Lahijani *et al.* (2006) revealed that Tea tree oil did not clean the canal walls as effectively as distilled water and NaOCl. It was thought that a material with less surface tension might be more effective in removal of smear layer (Goldman *et al.*, 1981). The poor results for tea tree oil might be related to its high surface tension. It might be more beneficial to change the extract of tea tree oil to a non oily version. It might be useful to test an aqueous extract or an emulsion of tea tree oil with less surface tension (Lahijani *et al.*, 2006).

Conclusion

Qmix & EDTA could effectively remove the smear layer from the coronal and middle thirds of the root canal. Smear layer removal with Qmix was better than with EDTA but statistically significant only in the apical third (p=0.005). Tea tree oil was not effective in removing smear layer although it was better than saline in the coronal and middle thirds but it was statistically significant in the coronal third (p=0.046). Further research is needed on the use of herbal root canal irrigants.

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