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Comparative Evaluation of Three Solvents Used in Endodontic Retreatment: A Scanning Electron Microscope Study

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Abstract: ***Non-surgical endodontic re-treatment is an attempt to re-establish healthy periapical tissues after inefficient treatment or re-infection of an obturated root canal system. Re-treatment requires the removal of defective root canal filling. The removal of gutta percha can be done with several techniques which include rotary files, ultrasonic instruments and hand files in combination with heat or chemicals. The objective of this study was to compare the efficacy of three solvents on the removal of root canal filling materials from the dentinal tubules during endodontic re-treatment. Forty single rooted teeth were selected for the study. After cleaning and shaping, the samples were obturated with gutta percha and a resin based sealer. They were stored for three months before being randomly divided into four groups: Eucalyptol (n=10), D-Solve (n=10), Canalsolve R (n=10) and Control (n=10). Re-treatment was done using the solvents and hand files. Following re-treatment the teeth were split longitudinally for SEM evaluation and the number of dentinal tubules free of obturating material in the middle and apical third was recorded. A significantly higher number of dentinal tubules were found to be free of obturating material in the eucalyptol group as compared to the other groups. Under the tested conditions it may be concluded that eucalyptol may be considered as a more efficient solvent as compared to D-Solve and Canalsolve R.***

Keywords: Canalsolve R; D-Solve; endodontic re-treatment; eucalyptol

1. Introduction

The foremost requirement of endodontic re-treatment is the removal of pre-existing endodontic filling material followed by disinfection of the root canal which is accomplished by chemo-mechanical re-instrumentation. Chemical solvents are used to solubilize the gutta-percha in order to remove it without damaging the tooth. Orange oil, eucalyptol, xylol, chloroform, halothane and rectified turpentine have all been used as adjuncts to remove endodontic filling materials.[1] In case of teeth obturated by the thermafill obturation technique; re-treatment can be carried out by combining heat with a solvent. It has been shown in previous studies that hand instrumentation requires significantly more time to remove root fillings as compared to ultrasonics and rotary instrumentation. Additionally, Nd:YAG laser was shown to be effective in re-treatment because it not only preserves the root canal dentin walls but also prevents temperature rise in the root, which could potentially harm the periodontium.[2]

In spite of all different re-treatment strategies, studies have shown that it is not possible to obtain root canal walls that are completely free of debris and residual infection.

Thus the aim of the present study was to evaluate the efficacy of eucalyptol, D-Solve (d-limonene) and Canalsolve R (Ammdent) as adjuncts during endodontic re-treatment on the removal of obturation material from dentinal tubules by Scanning Electron Microscopy (SEM).

2. Materials and Methods

Forty human single rooted teeth with straight roots were selected and then radiographed to ensure that they had a single canal, mature apex and less than five degree curvature.

The teeth were sectioned to provide remaining roots measuring 21mm in length. For all the samples working length was set at 20 mm and biomechanical preparation was done using crown-down technique with K-files. Instrumentation began with K-file size 80 and progressively smaller K-files were used to prepare to a final apical size #30 K-file (Dentsply Mailefer, Ballaigues, Switzerland).

At each change of instrument, the canals were irrigated with 5.25% sodium hypochlorite. 10% citric acid was used to irrigate the canals once instrumentation was done, to remove the smear layer, followed by a final rinsing with 20 ml of distilled water.

The canals were dried with paper points and obturation was done with gutta percha and Apexit sealer. The root canals were obturated using lateral compaction technique employing standardized gutta-percha cones, finger spreaders and accessory cones. Heated instrument was used to remove the excess gutta percha at the canal entrance followed by vertical compaction to condense it at the coronal third of the canal. The coronal access cavities were sealed with temporary filling material.

Radiographs were taken to confirm a homogeneous obturation of the root canal, lack of voids and proper length of the root canal obturation, before storage at 37ºC in 100% humidity (artificial saliva) for three months. The teeth were then randomly divided into four groups according to the solvent to be used: Group I: Eucalyptol, Group II: D-Solve, Group III: Canalsolve R and Group IV: Control. In control group, the filling material was not removed.

A reservoir for the solvents was created within the coronal third using #2 (0.70mm) and #3 (0.09mm) Gates Glidden drills to a depth of 3mm beyond the canal entrance and 0.4 ml of each solvent was delivered with a syringe to the sample reservoirs. After two minutes to allow for solvent

penetration, crown down instrumentation was initiated to removal the gutta percha using a size 60 K-file. Every 30 seconds, canal debris was removed by rinsing with 2 ml 5.25% NaOCl using a 30-gauge irrigation needle, before adding solvent and using sequentially smaller diameter files to remove gutta percha using a reaming motion. The end point of instrumentation was determined when a #30 K-file reached the working length. The total time taken to remove the filling material was 5 minutes.

Apical patency was checked using a #10 K-file before final irrigation with a 10 ml of citric acid and 10 ml with 5.25% NaOCl. All canals were dried with paper points.

Longitudinal grooves were prepared on the external surface of all roots before splitting the samples into two halves. One half of each sample was mounted on an SEM specimen holder before placement in a vacuum chamber after coating with a 20-nm thick gold-palladium layer. Microscopic analyses were done using a scanning electron microscope. All sample preparations were performed by the same operator.

For evaluation purposes, each sample was divided into coronal, middle and apical thirds. A single evaluator who was blinded to the specimen location, examined only the central region of the middle and apical thirds. SEM micrographs of the center of the middle and apical thirds were taken at 500X magnification that corresponds to an area of 367.2 μm^2. The number of dentinal tubules free of filling materials per mm^2 was statistically evaluated by Kruskal Wallis test.

3. Results

The test results demonstrate statistically significant difference in the mean dentinal tubules free of the restorative material between the four groups (P<0.001) both in middle and apical third of the root areas (Table 2).

In the middle third area, the Post hoc analysis revealed that group 1 (Eucalyptol) showed significantly highest mean dentinal tubules free of the restorative material as compared to the other groups; group 2 (D-solve) and group 4 (control)at P<0.001, also with group 3 (Canalsolve R) at P=0.002. This was followed by group 3 showing significant difference with group 2 and group 4 both at P<0.001 and group 2 having significantly higher mean dentinal tubules as compared with Group 4 (P<0.001) [Table 1].

In apical third area, the Post hoc analysis revealed that group 1 showed significantly highest mean dentinal tubules free of restorative material as compared to the other groups 2 and 4 at P<0.001. This was followed by group 3 showing significant difference with group 2 at P=0.007 and group 4 (Control) both at P<0.001 and group 2 having significantly higher mean dentinal tubules as compared to Group 4. However, no significant difference was seen between group 1 and group 3 (Table 1).

Group 1, group 3 and group 4 showed significantly higher mean dentinal tubules free of restorative material in the middle third area of the root canal as compared to the apical third (P=0.001). However, group 2 showed no significant difference between the middle and apical third areas (P=0.46) (Table 2).

Group 1(eucalyptol) showed the highest mean dentinal tubules free of the restorative material both in the middle apical third (Graph 1).

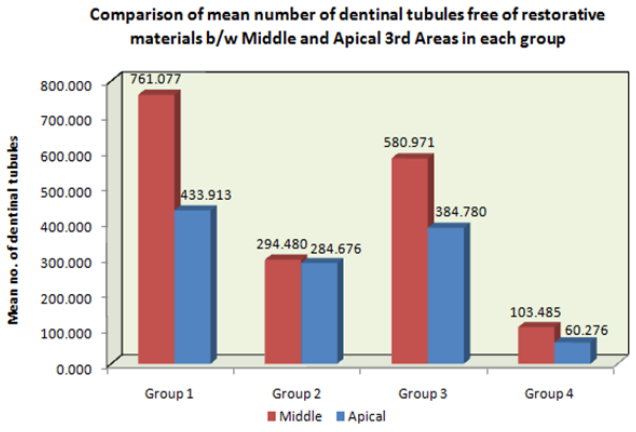
SEM micrographs of the evaluated areas show that in the middle and apical root thirds respectively, showing dentinal tubules free of filling materials after the endodontic retreatment using the tested solvents. White arrows in these figures point to open dentinal tubules (Fig. 2).

Multiple comparison of mean difference between 04 groups in the middle and Apical 3rd areas using Mann Whitney post hoc Test						
Area	G1 Vs G2	G1 Vs G3	G1 Vs G4	G2 Vs G3	G2 Vs G4	G3 Vs G4
Middle	<0.001*	0.002*	<0.001*	<0.001*	<0.001*	<0.001*
Apical	<0.001*	0.63	<0.001*	0.007*	<0.001*	<0.001*

Table 1: Multiple comparison of mean difference in the middle and apical third areas between different groups

Comparison of mean number of dentinal tubules free of restorative materials b/w Middle and Apical 3rd Areas in each group using Wilcoxon Signed Rank Test							
Groups	Areas	N	Mean	SD	Mean Diff	Z	P-Value
Group 1	Middle	15	761.077	88.875	327.165	-3.411	0.001*
	Apical	15	433.913	62.937			
Group 2	Middle	15	294.480	55.524	9.804	-0.739	0.46
	Apical	15	284.676	72.709			
Group 3	Middle	15	580.971	148.273	196.191	-3.408	0.001*
	Apical	15	384.780	135.808			
Group 4	Middle	15	103.485	20.170	43.210	-3.300	0.001*
	Apical	15	60.276	11.363			

Table 2: Comparison of mean number of dentinal tubules free of restorative materials between middle and apical areas in each group



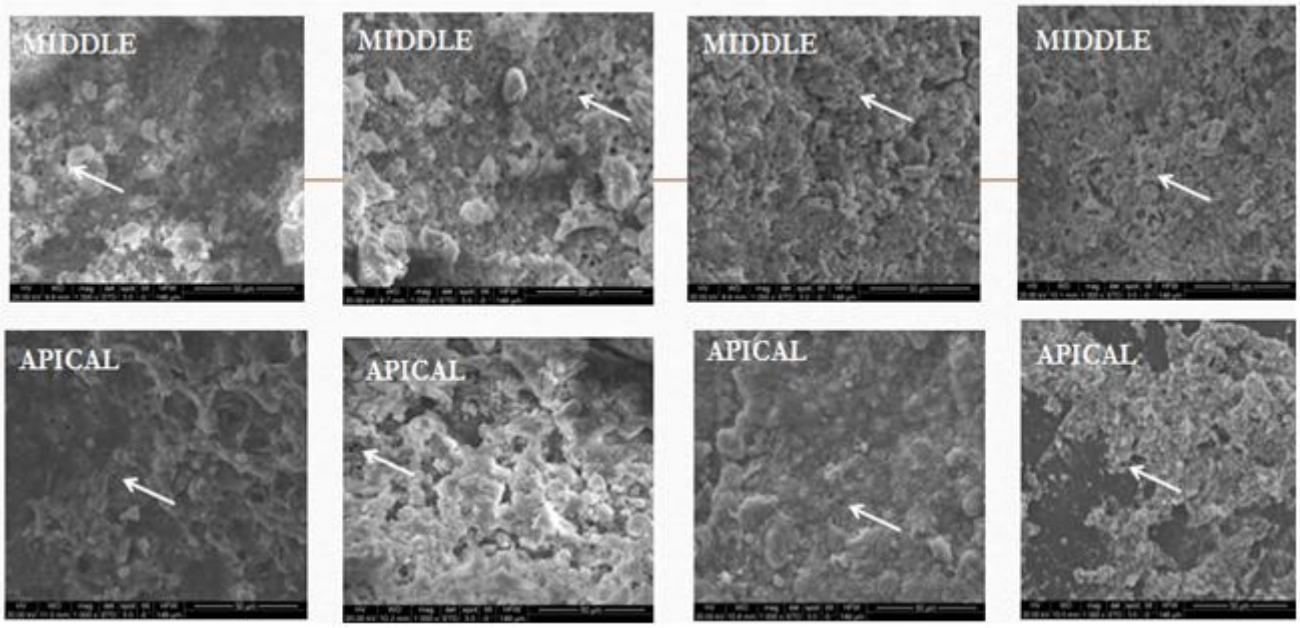


Figure 1: SEM micrograph images showing the middle and apical third in each group

4. Discussion

The re-treatment of a previously filled root canal is indicated when there is a persistent periradicular disease resulting from coronal microleakage, incomplete cleaning and shaping and complex anatomy. In this study 60 single rooted teeth were chosen because of their simple anatomic shape which would facilitate the removal of the filling material. Complications during retreatment procedures may be accounted for by the resistance of the filling material to instrument penetration. In this context, solvents serve as useful adjuncts to the mechanical action of instruments.

Although many endodontic retreatment studies have been reported, little clinical data are available regarding the time required to keep root canals soaked in the solvents during retreatment. A mean time of 1.5-10.8 minutes have been reported in laboratorial studies for retreatment of canals with laterally condensed gutta percha and sealer. In the present study the total time taken to remove the obturation material was five minutes.

The study also revealed statistically significant difference in the mean dentinal tubules free of the restorative material between the four groups. In middle 3rd area, group 1 (eucalyptol) showed significantly highest mean dentinal tubules free of restorative material as compared to the other groups. This was followed by group 3 (Canalsove R) showing significant difference with group 2 (D-Solve) and group 4 (control) and group 2 having significantly higher mean dentinal tubules as compared with group 4 (control).

In apical third area, group 1 (eucalyptol) showed significantly highest mean dentinal tubules free of restorative material as compared to groups 2 (D-Solve) and 4 (control). This was followed by group 3 (Canalsolve R) showing significant difference with group 2 (D-Solve) and group 4 (control) and group 2 having significantly higher mean dentinal tubules as compared with group 4. However, no significant difference was seen between group 1(eucalyptol) and group 3 (Canalsolve R).

The study also reveals that group 1 (eucalyptol), group 3 (Canalsolve R) and group 4 (control) showed significantly higher mean dentinal tubules free of restorative material in the middle third area of the root canal as compared to apical third. However, group 2 (D-Solve) showed no significant difference between the middle and apical third areas.

Morse and Wilcko (1978) and Hunter K R et al in two different studies, recommended eucalyptol as a solvent to for gutta percha during re-treatment.[3,4]The present study corroborates the results published elsewhere, which revealed that it is not possible to obtain root canal walls completely free of debris.[5]Tanomaru-Filhu et al in their study showed similar results, i.e. d-limonene was found to be less effective in dissolving gutta percha than eucalyptol.[6]

However, Hemant Kumar Yadav et al found both eucalyptol and orange oil to be similar in their ability to remove gutta percha while Gaurav Kulkarni et al in their study found that d-limonene was more efficient than eucalyptol in dissolving gutta percha.[7,8]

No studies have been done to evaluate the effectiveness of the newly introduced solvent by Canalsolve R, in endodontic retreatment.

5. Conclusion

During endodontic retreatment of root canals filled with gutta-percha and resin based sealer, eucalyptol showed superior results as compared to the newer solvent, Canalsolv R. Further research into the use of organic solvents is needed as they also have an added benefit of less cytotoxicity as compared to other inorganic solvents.

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