

**EFFECT OF DIFFERENT IRRIGATION TECHNIQUES AND SOLVENTS ON THE
CLEANLINESS OF THE APICAL THIRDRROOT CANAL IN ENDODONTIC
RETREATMENT WITH BIOCERAMIC BASED SEALER (IN VITRO)**

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ABSTRACT

Aim :To determine the effect of the combined use of solvents (eucalyptus oil and orange oil), file retreatment, ultrasonic irrigation and rotary brushes on the cleanliness of the apical thirrdroot canal that were re-treated.

Materials and Methods :25 dental samples which were divided into 5 treatment groups. Each group consists of five sample groups. Group A were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and ultrasonic irrigation techniques. Group B were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and rotary brushes irrigation techniques. Group C were specimens whose root canal filling material was removed using orange oil, file rotary retreatment and ultrasonic irrigation techniques. Group D were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and rotary brushes technique. The control group was specimens whose root canal filling material was removed using only a rotary retreatment file.

Results : Statistical assessment in all groups had effect and a significant difference in root canal re-treatment using solvents (eucalyptus and orange oil) and irrigation techniques (PUI and rotary brushes) was third apical root canal cleaning ($p < 0.05$).

Conclusion :This study showed that was an effect of using solvents (eucalyptus and orange oil) with irrigation techniques (PUI and rotary brushes) on the cleanliness of apical third of root canal. Also there was no significant difference between used eucalyptus oil with orange oil and PUI irrigation with rotary brushes on the cleanliness of the apical third root canal. However, the use of solvents and irrigation techniques can help clean the filling material in the apical third root canal in endodontic retreatment.

Keywords: Endodontic Retreatment, Solvent, Eucalyptus Oil, Orange Oil, Irrigation Techniques, Ultrasonic, rotary brushes

Introduction

Root canal treatment is not always successful and periradicular inflammation may persist or worsen after treatment. Non-surgical endodontic retreatment is the first choice in the presence of post-treatment cases due to intraradicular infection due to failure of root canal treatment. The use of sealers and gutta percha are the most widely used materials in root canal treatment. Gutta percha cannot bond to radicular dentin, but sealers are able to produce a bond between sealer and dentin. In the development of endodontic science, primary filling materials and sealers were developed based on dentin adhesion technology, so as to effectively seal the root canal and maintain the density between the sealer and the dentin surface (Sherif et al, 2018; Kfir et al, 2012; Naser et al, 2013). Several variations of sealer materials are based on zinc oxide eugenol, calcium hydroxide, glass ionomer, resin, silicone and bioceramic. The advantages of using a bioceramic-based sealer are that it is biocompatible with the surrounding tissue and contains calcium phosphate which enhances the biochemical properties and crystal structure that resembles apatite crystals in teeth and bones. This increases the bond between the sealer and the dentin in the root canal. The excess makes it difficult to clean the sealer material in the root canal on re-treatment (Al-Haddad et al, 2016). In Takarova's study using a bioceramic sealer, it was stated that cleaning of root canal filling material could not be achieved as a whole, especially in the apical part (Takarova et al, 2019). Sherif's study showed that there was a significant difference in the clearance of root canal filling material between coronal, middle and apical (Sherif et al, 2017). Several techniques are used to clean filling material from root canals, namely hand files, rotary system, ultrasonic, laser, heater and solvent (Sherif et al, 2018). Cleaning of gutta-percha using hand files with or without solvent can be time consuming, especially if the root canal filling was previously well filled (Kasam et al, 2016; Akpınar et al, 2012).

Solvents used in softening gutta percha include chloroform, halothane, benzene, tetrachlorethylene, xylene, eucalyptus oil and orange oil. However, some solvents have a level of toxicity to the periapical tissue. Therefore, an efficient and safe solvent is needed for endodontic retreatment (Kazi et al, 2018). Kazi et al examined the efficiency of different solvents for softening gutta-percha. They showed that a good softener of gutta-percha was chloroform but had high toxicity, so an alternative was introduced using eucalyptus oil for 2 minutes (Kazi et al, 2018). While Rehman et al compared chloroform with orange oil in softening gutta-percha, it showed that there was no significant difference between the two, so orange oil could be used as an effective alternative in softening gutta-percha. (Rehman et al, 2013). In re-root canal treatment, it is expected that gutta-percha and sealer must be clean from the walls to ramification of the root canal with chemomechanical techniques and the application of antibacterial agents (Tomar et al, 2018). The chemomechanical process requires the use of irrigation as a cleaning and disinfection of the root canal system. (Moliz et al, 2019; Zehnder, 2006). Irrigation agents consist of Sodium hypochlorite (NaOCl), EDTA, Citric acid, HEDP (1-hydroxyethylidene 1, 1-disphosphonate), as well as a combination of irrigation agents (MTAD, Tetraclean, QMix) and Chlorhexidine (CHX) (Moliz et al, 2019). Irrigation materials can work more effectively when in direct contact with the entire root canal wall. Variations of mechanical irrigation techniques consist of rotary brushes, continuous irrigation during rotary instrumentation, sonic, ultrasonic (continuous and intermittent), pressure alternation devices and Laser Activated irrigation (LAI) (Ragus et al, 2018; Sluis et al, 2014; Gu et al, 2009).

In performing root canal treatment, a combination of several techniques is needed to clean and remove all root canal filling material and bacteria to prepare for successful treatment. However, so far there has been no research showing the cleanliness of the

third apical root canal after repeated root canal treatment using a combination of solvent, re-instrumentation, ultrasonic irrigation techniques and rotary brushes.

Material and Method

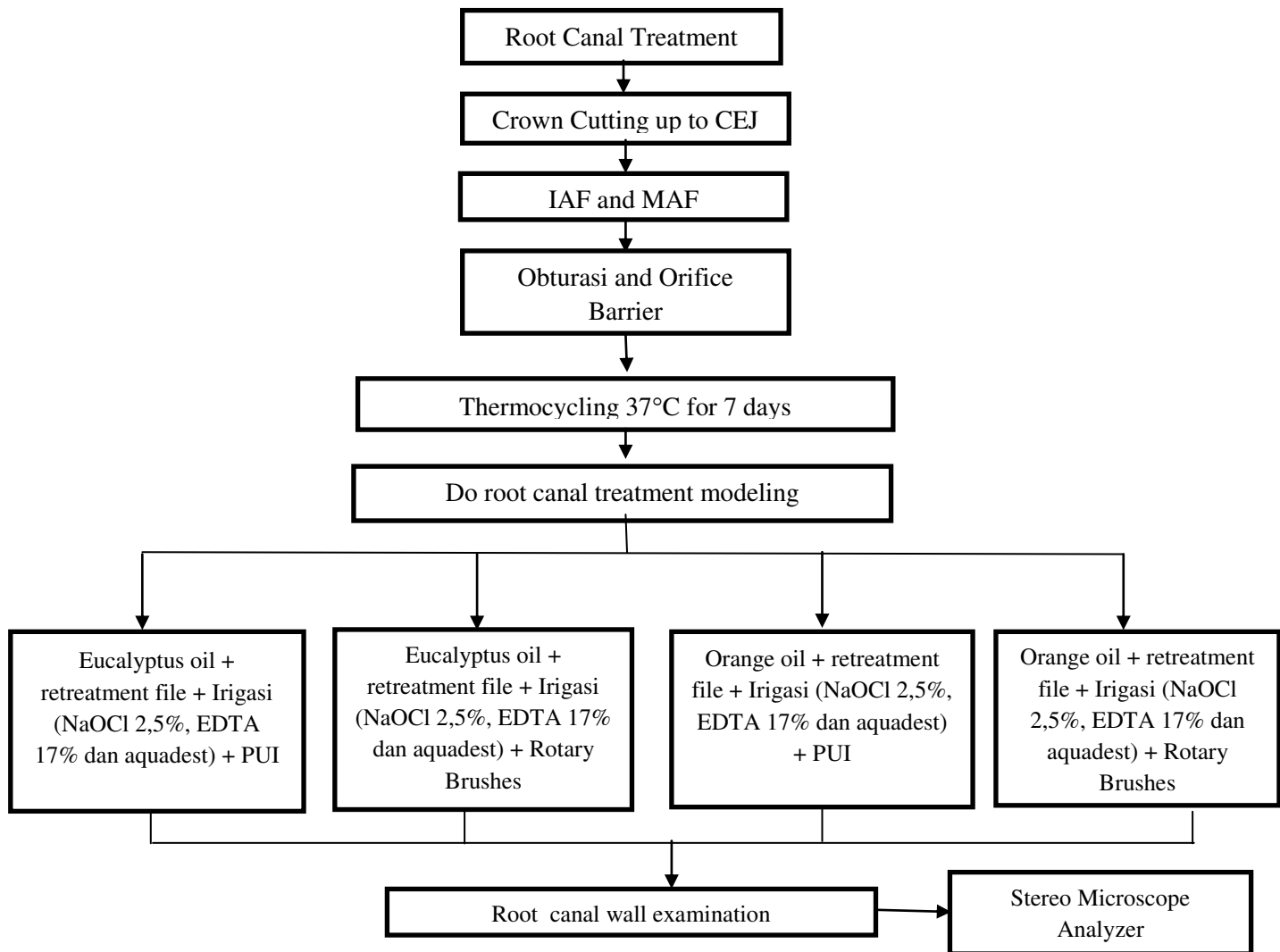
Research Tools and Materials

Research Tools :Masks and handsoons, Diamond bur disc, K-file #10 and #15 (Dentsply, Switzerland), Endo Motor (Dentsply, Switzerland), Rotary file One Curve size 14/.03, 25/.06 (Micromega), Rotary Retreatment AF Retreatment files 30/.09, 25/.08, 20/.07 (Fanta, China), 5 ml syringe for irrigation (Terumo, Philippines), Irrigation needle (CK-jet), Canal Brush Size S (Coltene), Passive ultrasonic irrigation (Acteon, USA), Gutta Cutter, spiritual lamp

Research Material :Eucalyptus oil (Young Living, US), Orange Oil – Citrol (Young Living, US), Sodium Hypochlorite (NaOCL 2.5%), EDTA 17% (Onemed), Alcohol 70% 0.5liter, Aquades 0.5 liter Aqua, Paperpoint, Bioceramic based sealer – OneFil (Medicus, Korea), Gutta Percha (Dentsply, Switzerland), RM GIC (Fuji 2 LC, GC, Japan), Stationary, Handsoon, Face mask

Population and research sample

Research population use extracted mandibular premolars for orthodontic purposes. Research Sample use Extracted mandibular premolars for orthodontic treatment: No caries on roots, Single or single rooted teeth and have one root canal, No crack on root, and the apex of the tooth is completely closed. The exclusion criteria are as follows: Teeth with double root canals, Teeth with excessively crooked root canal curvature and teeth that have previously had endodontic treatment



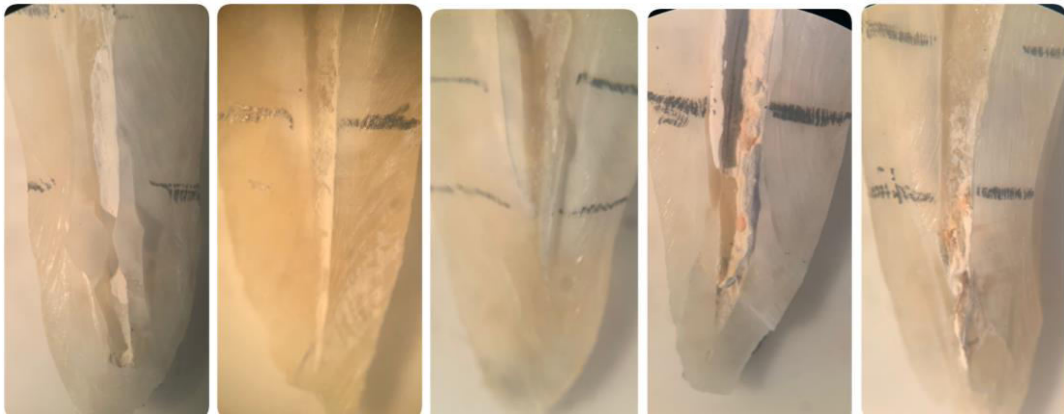
Result

This study was conducted to determine the effect of the combined use of solvents (eucalyptus oil and orange oil), file retreatment, ultrasonic irrigation techniques and rotary brushes on the cleanliness of root canal walls undergoing re-treatment.

This study was conducted on 25 dental samples which were divided into 5 treatment groups. Each group consists of five sample groups. Group A were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and ultrasonic irrigation techniques. Group B were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and rotary brushes irrigation techniques. Group C were specimens whose root canal filling material was removed using orange oil, file rotary retreatment and ultrasonic irrigation techniques. Group D were specimens whose root canal filling material was removed using eucalyptus oil, file rotary retreatment and rotary brushes technique. The control group was specimens whose root canal filling material was removed using only a rotary retreatment file.

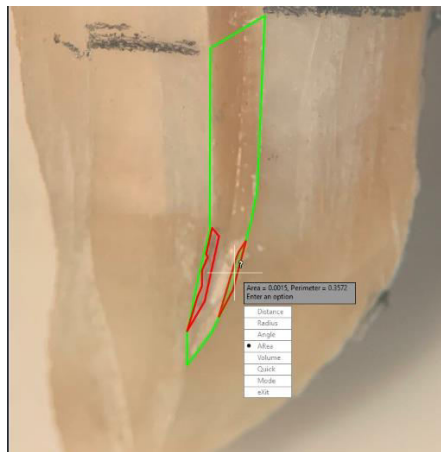
This research has been approved by the Research Ethics Commission (KEPK) Faculty of Medicine USU Medan through Ethical Clearance No. 78/ KEP/ USU/ 2021

Analysis with Stereo Microscope



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An image of the surface of the root canal wall after removal of the root canal filling material produced by a stereomicroscope with 1X (1:1) magnification using: a). Group A, solvent eucalyptus oil, file rotary retreatment and ultrasonic irrigation technique, b) Group B, solvent eucalyptus oil, file rotary retreatment and irrigation technique rotary brushes, c) Group C, solvent orange oil, file rotary retreatment and ultrasonic irrigation technique, Group D, orange oil solvent, rotary retreatment file and rotary brushes irrigation technique, e) Group A, rotary retreatment file



Calculation of root canal volume with AUTOCAD software

Table 1. Descriptive Statistic effect of solvent and irrigation techniques on percent residual in the third apical root canal.

Descriptives

Sisa (%)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Eucalyptus + PUI	10	22.0870	12.42709	3.92979	13.1972	30.9768	.18	42.41
Eucalyptus + Rotary	10	43.8070	22.24180	7.03348	27.8962	59.7178	5.15	68.63
Orange + PUI	10	34.4820	21.48615	6.79452	19.1117	49.8523	5.15	75.12
Orange + Rotary	10	35.0450	13.39073	4.23452	25.4658	44.6242	16.88	62.14
Kontrol	10	59.2350	30.05393	9.50389	37.7357	80.7343	10.91	93.38
Total	50	38.9312	23.59801	3.33726	32.2247	45.6377	.18	93.38

Table 2. The effect of solvent and irrigation techniques on the cleanliness of third apical root canal using Oneway ANOVA test

ANOVA

Sisa (%)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7546.427	4	1886.607	4.301	.005
Within Groups	19740.021	45	438.667		
Total	27286.448	49			

Table 3. Differences between groups effect of solvents and irrigation techniques on the percentage of residual in the third apical root canal using LSD test

Multiple Comparisons

Sisa (%)

LSD

(I) Kelompok	(J) Kelompok	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Eucalyptus + PUI)	Kontrol	-37.14800*	9.36661	.000	-56.0133	-18.2827
	Eucalyptus + Rotary	-21.72000*	9.36661	.025	-40.5853	-2.8547
	Orange + PUI	-12.39500	9.36661	.192	-31.2603	6.4703
	Orange + Rotary	-12.95800	9.36661	.173	-31.8233	5.9073
2 (Eucalyptus + Rotary)	Kontrol	-15.42800	9.36661	.106	-34.2933	3.4373
	Eucalyptus + PUI	21.72000*	9.36661	.025	2.8547	40.5853
	Orange + PUI	9.32500	9.36661	.325	-9.5403	28.1903
	Orange + Rotary	8.76200	9.36661	.355	-10.1033	27.6273
3 (Orange + PUI)	Kontrol	-24.75300*	9.36661	.011	-43.6183	-5.8877
	Eucalyptus + PUI	12.39500	9.36661	.192	-6.4703	31.2603
	Eucalyptus + Rotary	-9.32500	9.36661	.325	-28.1903	9.5403
	Orange + Rotary	-.56300	9.36661	.952	-19.4283	18.3023
4 (Orange + Rotary)	Kontrol	-24.19000*	9.36661	.013	-43.0553	-5.3247
	Eucalyptus + PUI	12.95800	9.36661	.173	-5.9073	31.8233
	Eucalyptus + Rotary	-8.76200	9.36661	.355	-27.6273	10.1033
	Orange + PUI	.56300	9.36661	.952	-18.3023	19.4283
Kontrol	Eucalyptus + PUI	37.14800*	9.36661	.000	18.2827	56.0133
	Eucalyptus + Rotary	15.42800	9.36661	.106	-3.4373	34.2933

Orange + PUI	24.75300*	9.36661	.011	5.8877	43.6183
Orange + Rotary	24.19000*	9.36661	.013	5.3247	43.0553

*. The mean difference is significant at the 0.05 level.

Based on the results in table 1, it is known that the average percent value of the remaining filling material on the root canal wall after removal of the filling material in group 1 is $22,087 \pm 12,427$. The mean value in group 2 was $43,807 \pm 22,242$. The mean value in group 3 was $34,482 \pm 21,486$. The mean value in group 4 was $35,045 \pm 13,391$. The mean value in the control group was $59,235 \pm 30,054$. In the calculation of the average, it can be concluded that the highest residual percent value is in the control group, while the lowest average value is in group 2.

The results of testing the data with the ANOVA test with the value obtained is $p = 0.05$, it can be concluded that there are significant differences between group 1, group 2, group 3, group 4 and control group (Table 2). Based on the results of the LSD test in table 3 which assesses the difference in the percent remaining in the apical 1/3 of the root canal, there is a significant difference in the control group with group 1, namely the p value = 0.000 ($p < 0.05$). In the control group with group 2, the value of $p = 0.106$ ($p > 0.05$) there was no significant difference. In the control group with group 3, namely the value of $p = 0.011$ ($p < 0.05$) there was a significant difference. In the control group with group 4, the value of $p = 0.013$ ($p < 0.05$) there was a significant difference. In group 1 and group 2, the p value = 0.025 ($p < 0.05$) there was a significant difference. In group 1 and group 3, the p value = 0.192 ($p > 0.05$) there was no significant difference. In group 1 and group 4, the p value = 0.173 ($p > 0.05$) there was no significant difference. In group 2 and group 3, the p value = 0.325 ($p > 0.05$) there was no significant difference. In group 2 and group 4, the p value = 0.952 ($p > 0.05$) there was no significant difference.

From the results of these comparisons, it is evident that the use of solvents and irrigation techniques greatly influences than not using them. However, in the group which proved to be no significant difference between group 2 and control, the retreatment file used also had an important role in cleaning the apical third of the root canal.

Discussion

Problems that arise after root canal treatment can be caused by the emergence or persistence of microorganisms in the root canal by bacteria characterized by microleakage. Eliminating etiological factors such as removal of necrotic tissue, bacterial biofilm, coronal leakage, recurrent caries and fractured teeth to obtain conditions conducive to healing, so that non-surgical root canal treatment is preferred over periapical surgical treatment for the treatment of persistent infections. The basic goal of non-surgical root canal treatment is to remove microbial irritants. Removing the entire filling material in the root canal is carried out with the aim of non-surgical re-treatment, which removes the remnants of necrotic tissue or bacteria that caused the failure of the previous root canal treatment (Machtou dan Reit, 2010; Sherif, et al, 2018).

Non-surgical root canal re-treatment performed on the root canal of the previous tooth was filled with gutta percha and sealer, thus requiring complete removal of the root canal wall. Lifting can be done using several methods including rotary file instruments or manual files, ultrasonic instruments, heating methods, lasers or a combination. These techniques can

be performed with or without the use of solvent root canal filling materials (Sherif, et al, 2018; Kasam, et al, 2016; Akpinar, et al, 2012).

Statistically these results showed a significant difference between groups. This is indicated by the results of the Oneway ANOVA test in the five sample groups with $p < 0.05$. These results indicate that the research hypothesis is accepted, that there is an effect of the use of solvents and instrumentation protocol during non-surgical endodontic retreatment, that none of the additional techniques was able to clean root canal sealers, especially with the use of bioceramic sealers. This could be due to the nature of the bioceramic sealer which has good adhesiveness to the dentinal tissue (Crozet et al, 2021).

The adhesive properties of bioceramic sealers can interact with dentin in the root canal which can provide biomineralization and form a hybrid layer on the dentin. The advantages of bioceramic sealers are that they can bind to the dentin layer in the root canal compared to resin-based sealers and bioceramic sealers can seal the apical foramen making it difficult to reach the apical patency (Cirstea et al, 2020; Viapiana, 2016). This can make it difficult to clean one third of the root canal, even using solvents (eucalyptus and orange oil) and irrigation techniques (PUI and Rotary Brushes).

The irrigation technique used is PUI and Rotary brushes, aiming for the irrigation solution to flow throughout the root canal system by making contact with the substrate and providing lubricant for the instrument which ensures the flow of the solution throughout the root canal to maintain an effective concentration of active chemical components and compensate for their inactivation. Ensure the strength of the root canal wall to release the substrate, as well as prevent extrusion of the irrigant into the periapical tissue (Boutsioukis et al, 2015; Gregorio et al, 2014). PUI technique was found to be more effective than the conventional technique for the removal of root canal filling material from the cervical and middle thirds during endodontic retreatment. PUI technique eliminates sealer debris in areas that cannot be accessed by conventional retreatment files. free intracanal movement of the file is necessary for easy penetration of the solution into the root canal system and a more powerful cleaning effect. Energy transmitted from a file to the irrigant by means of ultrasonic waves that induce two physical phenomena: stream and cavitation of the irrigant. The acoustic stream can be defined as rapid movement of the fluid in a circular or vortex shape around the vibrating file. A study shows that the cleaning effect of the GF Brush technique is superior to PUI technique in the apical area (Nguyen et al, 2019). It caused characteristics of the GF Brush technique may contribute to the better cleaning efficiency throughout the canal system, particularly the apical region. In this study, the PUI technique and rotary brushes with eucalyptus oil as solvent had significant differences ($p < 0.05$). PUI technique with eucalyptus oil has less percent of residual in the third apical root canal than rotary brushes. However, there was no significant difference between the PUI technique and rotary brushes with the use of orange oil as a solvent ($p > 0.05$).

Several organic solvents have been investigated for dissolution capability in endodontic retreatment. Eucalyptus oil and orange oil is organic solvent in endodontics caused of safety, biocompatibility, and noncarcinogenicity. This is caused by bioactive compounds that act on the solvent used and can dissolve the root canal filling material. The bioactive compounds found in eucalyptus oil consist of 1,8-cineole, α -pinene, β -pinene, p-cymene, limonene, citronellal dan citionellol (Zhanget al, 2010). While orange oil, the main compound working is monoterpene hydrocarbons consisting of limonene, γ -terpinene dan β -myrcene (Lin et al, 2021). In this study, orange oil and eucalyptus oil does not show a significant different abilities for rotary brushes and PUI techniques. In present study, eucalyptus oil and

orange oil were found similar in their ability to dissolve Apexit Plus and Endomethasone N (Yadev et al, 2016).

Conclusion

The results of this study showed that there was an effect of the use of solvents (eucalyptus and orange oil) with irrigation techniques (PUI and rotary brushes) on the cleanliness of the apical third of the root canal. This is also supported by statistical analysis which shows a significant difference between groups ($p < 0.05$).

This study also showed that there was no significant difference between the use of eucalyptus oil and orange oil and PUI irrigation techniques with different rotary brushes on the cleanliness of the apical third of the root canal. However, the use of solvents and irrigation techniques can help clear the filling material in the apical third of the root canal in endodontic retreatment.

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