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EVALUATION OF THE DISSOLVING EFFICACY OF ESSENTIAL OILS ON ENDODONTIC OBTURATING MATERIALS: AN IN VITRO STUDY.

Dental Science

Dr. Rakesh Pyla* MDS Department of Pedodontics and Preventive Dentistry, GITAM Dental College and hospital.*Corresponding Author

Dr Jai Kiran Killada Reader, Department of Pedodontics and Preventive Dentistry, GITAM Dental College and hospital.

Dr V Raja Sekhar Professor, Department of Pedodontics and Preventive Dentistry, GITAM Dental College and hospital.

ABSTRACT

Aim: Endodontic retreatment is a procedure that removes the filling materials from the root canals followed by their cleaning, shaping and obturation. This in-vitro study aimed to compare and evaluate the ability of various essential oils as solvents in dissolving gutta-percha, epoxy resin, and zinc oxide eugenol (ZOE) cements. **Materials and methods:** A total of 28 cylindrical specimens in each group ZOE, epoxy resin, 28 ISO size 40 gutta-percha cones were prepared and divided into four groups for immersion in the different solvents, i.e. lemon oil, citronella oil, lavender oil, and TCE(Tetrachloroethylene (control)) for 5 minutes. The obturating materials dissolution in the solvents were obtained by the difference between the pre-immersion original weight and the post-immersion weight on a digital analytical scale. Data were statistically analysed by a paired t-test and Analysis of Variance (ANOVA) ($p < 0.05$). **Results:** Order of efficacy of dissolution of essential oils was found to be lemon oil > Citronella oil > Lavender oil and was highly significant ($p < 0.01$). In all the solvents, Gutta-percha showed maximum dissolution (F-value:149.56) followed by ZOE(89.07) and resin sealer least (23.86). **Conclusion:** It can be concluded that the lemon oil can be used as a solvent for dissolving obturating materials.

KEYWORDS

Essential Oils; Gutta-percha; Lemon Oil; Solvents; Tetrachloroethylene.

INTRODUCTION:

Endodontic retreatment is a procedure that removes the filling materials from the root canals followed by their cleaning, shaping and obturation. Endodontic retreatment's success to re-establish healthy periapical tissues depends on several factors such as accurate diagnosis, knowledge of tooth morphology, correct chemical-mechanical preparation, and tri-dimensional filling of the root canal system. It has been reported that the success of endodontically treated teeth range from 86 to 95% .[1,2]

Endodontic retreatment involves thorough debridement and cleaning of an infected pulp tissue's root canal so the canal space can be shaped and prepared to be filled with an inert material, thus minimizing any re-infection chances. Removal of root canal filling materials can be achieved by different techniques, including endodontic rotary files systems, endodontic hand files, ultrasonic instruments and/or the combinations of these with heat or chemical substances.[3,4]

Different sealers are available in the dental market featuring variable adhesive and sealing properties. Gutta-percha, zinc oxide eugenol sealers are considered one of the oldest and most popularly used endodontic cement, known for their excellent sealing ability and adequate tissue tolerance. Epoxy resin-based cement is widely used as root canal sealers as they have presented better-sealing ability and good adhesion with low solubility and disintegration. A solvent is highly recommended to facilitate the removal of gutta-percha by softening it with minimal damage to the tooth structure.[5]

Currently, the use of a solvent is recommended to facilitate the removal of gutta-percha by softening it without damaging the tooth[6]. According to Stabhouz and Friedman, solvents' use is essential for filling material removal within dentinal tubules and ramifications, therefore making easy the biomechanical preparations and the penetration of the irrigant solutions intracanal medications.[7]

The most common organic solvents used in endodontic retreatment are chloroform, Eucalyptol, xylene, and halothane. Chloroform (trichloromethane)is one of the most widely used solvents because of its efficiency, fast action, and low cost. However, it exhibits some cytotoxic degree for the periapical tissues and recent studies identified it as a potential carcinogen. Therefore, the interest has been revived to identify an alternative solvent to soften the obturating materials during removal procedures[8]

Essential oils have been reported to dissolve most of the endodontic sealers and are safe and useful. Furthermore, essential oils are known to possess antimicrobial effects against a wide variety of oral bacteria[9].

There are few published data on solubility profiles of essential oils commonly employed in root canal retreatment. Whilst methods for gutta-percha removal have been well researched, far less attention has been focused on removing other filling materials from canal walls, and from anatomical ramifications where they may be inaccessible to mechanical methods of removal[10]. Hence, the present study is designed to evaluate essential oils such as lemon oil, citronella oil and lavender oil in dissolving root canal filling materials.

Materials and methods:

Study design:

An observational study was conducted in the Department of Pedodontics and Preventive Dentistry, GITAM Dental College and Hospital, with the Department of Biotechnology, GITAM University. The solubility efficacy of lemon oil, citronella oil, and lavender oil on obturating materials such as zinc oxide eugenol cement, epoxy resin sealer gutta-percha was analysed. Ethical clearance for this study was obtained from the institutional review board.

The procedure of collection of data:

This study's essential oils were lemon oil, citronella oil, and lavender oil serve as test groups. Tetrachloroethylene was taken as control. The obturating cements were divided into three groups as follows:

Group 1: Zinc oxide eugenol cement
Group 2: Epoxy resin sealer
Group 3: Gutta-percha

A total of 28 cylindrical specimens for each group of ZOE, epoxy resin sealer were prepared with the dimension of 6 mm in height and 3mm in diameter according to ISO 9917.36 using plastic moulds and 28 ISO size 40 gutta-percha cones were taken. Each obturating material is tested with lemon oil, citronella oil, lavender oil and tetrachloroethylene (control) with 7 sub-samples in each group.

The solvents were dispersed with the help of liquid dropper into the dappen dish. 5 ml of essential oils have been dispersed, and the samples were immersed in these oils. Before immersing, the weight of obturating material in grams (up to four decimal places) was measured 3 times on an analytical balance. The mean values were then calculated, and their respective values have been noted. Further, they were immersed in the essential oil solvents for a 5 minutes immersion period, and the time was recorded with a stop watch.

After completion of 5 minutes, the samples were taken out from the solvent and kept on the paper napkins, so that the solvent on the samples are absorbed. The samples that were distorted or broken

during the process were excluded from the study. Then the samples were allowed to dry for 24 hours. After 24 hours, they were again measured using an analytical balance.

The extent of obturating material dissolution from the specimen was calculated from the difference between the original weight of samples and their final weight using the following equation:

M=M2- M1

Where,

M2 = Post immersion weight

M1 = Pre immersion weight

Their difference in immersion weights have been noted and was subjected to statistical analysis.

A paired t-test and one way ANOVA analysis followed by Tukey's multi-factorial analysis of variance ANOVA test were performed to detect significant differences between subgroups. Statistical analysis was performed using SPSS version 22 software. A P values < 0.05 was considered to be statistically significant. (listed in tables 1and 2.)

RESULTS

A total of 28 sub-samples of solvents were considered for analysis.

Table 1: Comparison of pre and post immersion weights % decrement in the cements using Lavender, Citronella, Lemon and TCE.

Cements	Materials		Mean	SD	% decrement	t-value	P-value
Gutta-percha	Lavender	Pre	0.12	0.002		12.56	<0.01 HS
		Post	0.10	0.002	-12.72		
	Citronella	Pre	0.12	0.002		-0.82	0.42
		Post	0.22	0.339	-18.87		
	Lemon	Pre	0.12	0.003		18.09	<0.01 HS
		Post	0.86	0.003	-30.01		
	TCE	Pre	0.12	0.003		37.69	<0.01 HS
		Post	0.06	0.002	-44.86		
Zinc oxide eugenol	Lavender	Pre	0.27	0.014		11.98	0.79
		Post	0.27	0.014	-0.49		
	Citronella	Pre	0.26	0.019		0.57	0.57
		Post	0.25	0.019	-0.44		
	Lemon	Pre	0.26	0.013		9.94	0.34
		Post	0.25	0.013	-1.62		
	TCE	Pre	0.27	0.016		1.22	0.24
		Post	0.26	0.013	-5.98		
Resin	Lavender	Pre	0.27	0.016		0.149	0.88
		Post	0.27	0.016	-0.75		
	Citronella	Pre	0.27	0.012		0.178	0.86
		Post	0.27	0.012	-2.29		
	Lemon	Pre	0.27	0.020		0.410	0.68
		Post	0.27	0.020	-2.66		
	TCE	Pre	0.28	0.015		2.034	0.06
		Post	0.26	0.015	-3.50		

HS: Highly significant; TCE: Tetrachloroethylene

Lemon oil and lavender oil showed a significant difference in pre and post weights for gutta-percha. Lemon oil, lavender oil, and citronella oil demonstrated decrement in the post weights of zinc oxide eugenol and resin cements but were not statistically significant.

Table 2: Comparison of mean difference in pre and post weights of the solvents for different obturating materials.

Cements	Diff of pre & post	Mean	SD	F-value	P-value
ZOE	TCE	0.009	0.0039	89.07	0.06
	Citronella	0.006	0.0002		
	Lavender	0.002	0.0001		
	Lemon	0.007	0.002		
Resin	TCE	0.016	0.003	23.86	0.09
	Citronella	0.001	0.0006		
	Lavender	0.001	0.0005		
	Lemon	0.004	0.0017		
Gutta-percha	TCE	0.056	0.0034	149.56	<0.01 HS
	Citronella	-0.105	0.34		
	Lavender	0.015	0.0032		
	Lemon	0.037	0.005		

HS: Highly significant; TCE: Tetrachloroethylene

Gutta-percha had statistically significant dissolution compared with zinc oxide eugenol and resin-based obturating material. The mean of the pre and post weight difference for gutta-percha was significantly greater with lemon oil compared with other citronella and lavender oil and lower than TCE ($p<0.01$) (Table 2)

DISCUSSION:

The use of solvents in dentistry decreases the working time in the cases requiring removing the filling material. Solvents help in softening of filling material allows easy penetration of the instruments inside the filled root canal. However, due to the genotoxic and cytotoxic potential of the solvents such as chloroform, halothane and xylene, a biocompatible material allows effective removal of the filling material, resulting in faster treatment and better capacity of cleanness and disinfection are under investigation[11].

The present study comparatively evaluated the dissolving ability of Citronella oil, Lavender oil, and Lemon oil on gutta-percha, zinc oxide eugenol, and epoxy resin at 5minutes immersion time intervals. All the obturating materials used in this study were soluble to some extent in the three essential oils. Among the essential oils, lemon oil was more effective, followed by citronella and lavender oil. The percentage decrement in the pre and post weights dissolution of gutta percha with lemon oil was significantly higher ($p > 0.05$) compared to other essential oils. Gutta-percha (0.037 0.005) had the most significant capacity for dissolving with lemon oil compared with zinc oxide eugenol and resin cements. Softening and mechanical removal of obturating materials proves to be not only effective but also a biologically safer procedure.

The time duration of 5 minutes for obturating materials dissolution is selected based on the studies performed by Gomes et al., Mushtaq M et al., Jeeraphat Jantarat et al. [8,12,13] According, to these studies, the greatest percentage of dissolution occurred after the first minute and the remaining time would be sufficient for dissolving the smaller amount of material, suggesting that the solution must be used for minimum five minutes.

Among the natural oils tested, lemon oil was significantly effective compared to citronella and lavender oil. However, lemon oil exhibited lower dissolution capacity than TCE. Studies by Martos et al. and Scelza et al. have shown similar dissolution behaviour of orange oil, Eucalyptol, chloroform, and xylol[14,15]. However, Mushtaq et al. have stated that orange oil's dissolving capacity is inferior to chloroform and xylene. The presence of high monoterpene hydrocarbon levels, d-limonene may contribute to the increased dissolution potential of the lemon oil[16]. The primary composition of lemon oil is 70% d-limonene, while citronella oil contains 9-11% and lavender oil 2-3% d-Limonene[17]. The oil that contains a higher percentage of d-limonene has a greater capacity to dissolve gutta-percha and other root canal sealers[12].In addition to d – limonene, the constituents in these essential oils are α-pinene, sabinene, β-pinene, β-myrcene, linalool, m-cymene and 4-terpineol. Alpha pinene, possesses antibacterial, anti-oxidant properties and have shown have good dissolution potential[18].

Gutta-percha (0.037 0.005) had the greatest capacity for dissolving with lemon oil compared with zinc oxide eugenol and resin cements. Their chemical properties can explain the mechanism of each solvent in dissolving gutta-percha. Gutta-percha is one of the natural rubbers, composed of trans-1,4-polyisoprene or polyterpenes[18]. Lemon oil is a non-polar solvent and was experimentally observed to penetrate the polymer strands with similar forces of chloroform, which held the polymer chains together. This process separates the polymer strands held together and helps in the dissolution of guttapercha[12].

The dissolution by the essential oils was least for epoxy resin sealer. Similarly, in a study conducted by Yadav et al. found Adseal (an epoxy resin-based material) showed the lowest solubility level than other sealers in all the solvents[3]. Martos *et al*. reported that the efficacy of eucalyptus oil, orange oil, xylene, and chloroform to dissolve EZ-Fill (epoxy resin-based sealer) was not significantly different from each other at 2 min[14]. The essential oils exhibiting less dissolution for resin sealer are attributed to incomplete penetration of the 3D lattice, which is formed during polymerization and cross-linking of the monomer.

The present study found that the dissolution capacity obtained for tetrachloroethylene (control) was significantly more than the lemon oil, citronella oil and lavender oil at 5 minutes. Tetrachloroethylene has primary dissolution capacity for gutta-percha. The present study results agree with Mushtaq et al., who reported high solubility with tetrachloroethylene (p=0.00) for softening gutta.percha/resilon during treatments. Alberto et al. found that chloroform had significantly highest solubilizing effect and the ability to dissolve gutta-percha ($p < 0.05$) compared to other groups. Hansen., et al., Scelza., et al., and Rehman., et al. found efficiency of lemon or citrus solvents similar to TCE, recommending them as a suitable solvent.[19,15,20] However, the degree of toxicity should be determined to use it in the clinical environment.

The present study's critical limitation includes the fact that only a part of the results can be applied to a clinical situation as only the core obturating material will be in direct contact with the solvent, limiting the dissolution. Future research considering the clinical factors such as root configuration, wettability, the solvent pH and the obturating materials age should be investigated.

CONCLUSION

The lemon oil showed statistically significant dissolving effects in softening obturating material after 5 min of immersion. Although TCE has the highest dissolving efficacy amongst the tested endodontic solvents, it cannot be recommended for standard use given the toxicity and carcinogenic effects.

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