Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2018;7:3:110-116.

The Effectiveness of Eucalyptus Oil, Orange Oil, and Xylene in Dissolving Different Endodontic Sealers: An In-Vitro Study

Ishani Shah[1*] Shraddha Chokshi[2] Shashin Shah[3] Zarana Sanghvi[4] Pruthvi Patel[5] Khushbu Shah[6]

[1]Post Graduate student, Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College, Ahmedabad, Gujarat, India.

[2]Professor and Head, Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College, Ahmedabad, Gujarat, India.

[3]Professor and Head, Conservative Dentistry and Endodontics, Goenka Research Institute of Dental Science, Gandhinagar, Gujarat, India.

[4]Professor, Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College, Ahmedabad, Gujarat, India.

[5]Professor, Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College, Ahmedabad, Gujarat, India.

[6]BDS, MPH, Rutgers, USA.

ABSTRACT

Aim: To comparatively evaluate the dissolution effectiveness of different solvents on different sealers. To evaluate the dissolution effectiveness of eucalyptus oil, orange oil, xylene, and distilled water on AH 26, Endomethasone N and Sealapex root canal sealers.

Materials and Methods: About 48 samples of root canal sealers, AH 26, Endomethasone N and Sealapex (16 for each sealer) were prepared and divided into four groups of 4, each for immersion in different organic solvents. Each group was further subdivided into two subgroups (n =2) for 2 and 10 min of immersion time. The mean percentage of weight loss was determined for each sealer in each solvent at both time periods. Data were statistically analyzed by One way analysis of variance and significance of mean difference was obtained (P < 0.05) by the same.

Results: Xylene was the most effective solvent for Sealapex (calcium hydroxide based sealer). Orange oil was most effective for AH 26 (resin based sealer). Eucalyptus oil was most effective for Endomethasone N (Zinc Oxide based sealer) used. All the sealers showed more dissolution in all the solvents at 10 min time period than 2 min. In distilled water, insignificant sealer dissolution was observed.

Conclusion: In general, xylene was the most effective in dissolving root canal sealers than other organic solvents.

Keywords: Orange oil; root canal sealers; solubility; weight loss; xylene; eucalyptus oil.

INTRODUCTION

Non surgical endodontic retreatment is an attempt to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated root canal system because of coronal or apical leakage. It requires regaining access to the entire root canal system through removal of the defective root canal filling, further cleaning and shaping if required and reobturation.[3][4] Success rate of endodontically treated teeth ranges from 86 to 95% and retreatment should be done for failure of root canal treated teeth.[3][5]

The major cause for the "failure" of primary endodontic therapy is persistent intra- and extra-radicular microbial infections. In every failed case, whenever possible, nonsurgical endodontic retreatment should be preferred instead of radical interventions such as apical surgery or extraction because it is less invasive and has good long-term survival rates. During retreatments, for the retrieval

Received: Jan. 17, 2018**: Accepted**: Feb. 10, 2018
*Correspondence Dr. Ishani Shah.
Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College, Ahmedabad, Gujarat, India.
Email: shahishani24gmail.com

pISSN 2278-0076
eISSN 2321-9270

of obturating materials, several techniques such as hand files, rotary files, and ultrasonic instruments either alone or in combination with heat or solvents have been used. Gutta-percha along with different endodontic sealers is the most commonly used obturating material. Its removal is a prerequisite for any retreatment endodontic therapy. The removal techniques are dependent on the anatomy, size and regions of the root canal, time, overfilled or overextended, and/or underfilled or underextended obturations. [1]

A combination of methods is frequently preferred to achieve a safe, efficient, and potentially completely remove these obturating materials from the root canal system. However, various evidence-based studies till date have reported that sealer residues, especially present on canal walls and in their microscopic ramifications, may either remain inaccessible or resist dissolution. Therefore, complete removal of sealers may varies considerably. In such cases, organic solvents play a vital role in the thorough removal of endodontic sealers. This facilitates the efficient disinfection of the root canal system and thus the probability of its long-term treatment success.

Although chloroform is considered as the most effective solvent in nonsurgical retreatment, it has been banned by the U.S. Food and Drug Administration in 1976 due to its carcinogenic potential and toxicity to the tissues.[8][1] Therefore, various alternatives such as halothane, rectified turpentine, Endosol R(formamide and 2-phenyl ethanol) and E benzene, methyl chloroform, ether, xylene, orange oil, and eucalyptol have been suggested and used for softening of filling materials.[1,2,7]

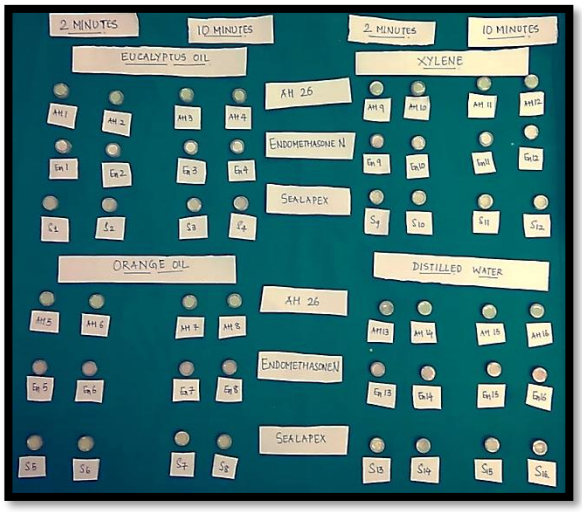
Though studies have been performed to evaluate dissolving efficacy of organic solvents on various root canal sealers, yet more studies are needed, as more advanced materials have been introduced to make up for the ideal requirements of the sealer along with the obturating material. Therefore, a simple, reproducible, and cost-effective laboratory study was carried out to comparatively evaluate the effectiveness of eucalyptus oil, orange oil, and xylene in dissolving Endomethasone N, Sealapex, and AH 26.

MATERIALS AND METHOD

Standardized stainless steel molds (8 mm diameter, 2 mm height) were used to prepare forty eight samples (sixteen for each endodontic sealer).

- Group A: Endomethasone N (Septodont, Saint Maur, France),
- Group B: Sealapex (Sybron Endo/Kerr; Orange, Calif.) and
- Group C: AH 26 (Dentsply/Maillefer, Tulsa, Okla)

Sixteen samples of each group were subdivided into 4 groups (n=4) for immersion into four different solvents. Amongst them, two were kept for 2 min as immersion period and two were kept for 10 min as immersion time period. Each sealer was mixed according to the manufacturer's instructions. Freshly mixed materials were carefully poured into the sample molds placed on a glass slab using a 2 ml syringe to prevent air entrapment, and a microscope slide covered with cellophane strip was then pressed onto the upper surface to make the surface flat. All samples along with their steel molds were then transferred to a chamber with 80% relative humidity and 37°C temperature and left untouched to set sealers for 48 h and then removed from the chamber.



Excess material was then removed with the help of a scalpel. The samples were weighed in grams (up to 3 decimal places) 3 times on an analytical balance (Cartlon scalex). The mean values were then

Table 1: Mean percentage with standard deviation (±) of weight loss for each endodontic sealer in different organic solvents at 2 and 10 min.

	Eucalyptus Oil		Orange Oil		Xylene		Distilled Water	
	2 Minutes	10 Minutes	2 Minutes	10 Minutes	2 Minutes	10 Minutes	2 Minutes	10 Minutes
Group A	0.025±0.021	0.028±0.032	0.00±0.00	0.015±0.021	0.020±0.014	0.020±0.014	0.005±0.007	0.023±0.004
Group B	0.005±0.007	0.020±0.00	0.005±0.007	0.005±0.007	0.038±0.011	0.070±0.028	0.030±0.014	0.005±0.007
Group C	0±0	0.003±0.004	0.015±0.007	0.020±0.014	0.005±0.007	0.010±0.014	0.005±0.007	0.010±0.00

calculated. After the specified immersion period in 15 ml of each solvents, all samples were rinsed with triple distilled water to remove the decomposed loosen debris and were then blotted dry. Further then, they were allowed to dry for 24 hrs in an oven, and then again weighed.

RESULTS

- In all solvent groups, all the three sealers showed more weight loss at 10 min than 2 min except dissolution of sealapex in distilled water.
- Solubility of Endomethasone N (Group A) was maximum in eucalyptus oil at 10 min(0.028±0.032)> eucalyptus oil at 2 min(0.025±0.021)> distilled water at 10 min(0.023±0.004) >xylene at 10 min(0.020±0.014)=xylene at 2 min(0.020±0.014)>orange oil at 10 min(0.015±0.021)>distilled water at 2 min (0.005±0.007)>orange oil at 2 min(0.00±0.00)
- Solubility of Sealapex (Group B) was the maximum in xylene at 10 min(0.070±0.028)>xylene at 2 min(0.038±0.011)> distilled water at 2 min(0.030±0.014)>eucalyptus oil at 10 min(0.020±0.00)> eucalyptus oil at 2 min(0.005±0.007)=orange oil at 10 min=orange oil at 2 min= distilled water at 10 min(0.005±0.007).

Solubility of AH 26 (Group C) was the maximum in orange oil at 10 min(0.020±0.014) > orange oil at 2 min (0.015±0.007)>Xylene 10 min (0.010±0.014)> distilled water at 10 min(0.010±0.00)> xylene at 2 min=distilled water at 2 min(0.005±0.007)>eucalyptus oil 10 min(0.003±0.004)>eucalyptus oil 2 min(0±0).

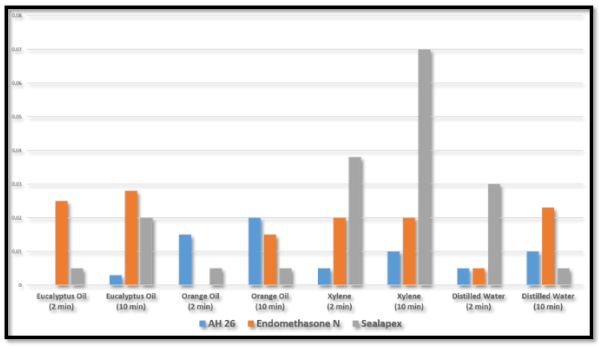
DISCUSSION

The basic aim of nonsurgical endodontic retreatment is to prevent the reinfection of an obturated root canal system because of coronal or apical leakage. The procedure involves regaining access to the entire root canal system through removal of the primary root canal filling, further cleaning, thorough disinfection and reobturation. [4]

Removing as much sealer and filling material as possible from inadequately prepared and filled root canals in re-treatment cases is critical to uncover remnants of necrotic tissue or bacteria that may be responsible for periapical inflammation or failure. [13] Various solvents are used to soften and dissolve gutta-percha and sealers, as follows; chloroform, eucalyptol oil, xylene, halothane, turpentine oil and pine needle oil. [14][3] When small, underprepared and curved canals need negotiation, solvents and small K-type files are best suited.

Very strong solvents are also capable of softening the enamel and dentin, in turn promoting canal transportation and chemical pericementitis if penetrated beyond the apex. There exist no specific standards for the measurement of root canal sealer solubility in organic solvents. The method used in

this in vitro investigation is similar to the previous studies. [1]



Graph 1: Graph showing dissolution of different sealers in different solvents at 2 min and 10 min.

Various studies have reported that a mean time of 1.5–10.8 min is required for the removal of very well-compacted obturating materials by instrumentation with or without solvents. In the present study, immersion time of 2 and 10 min for standardized samples allowed us to demonstrate clear differences in the solubility profiles of the endodontic sealers used in various solvents. To enhance the accuracy of the measurements, one sealer sample was used for just one immersion period, thus excluding its undesirable weight loss because of the repeated drying and immersion. After the specified immersion period, all samples were washed with distilled water to remove the decomposed loosen debris. [1][15]

Organic solvents are usually employed in paint industries to soften the coated materials for their easy removal. [15] These solvents can be applied in retreatment therapy for the removal of resistant or strongly adhered sealers in canal irregularities and ramifications. Several organic solvents have been investigated in the past for their softening or dissolution capability in endodontic retreatment. [3][24]Since all solvents are known for their toxicity to tissues to variable extent [25]the selection of an ideal organic solvent for any nonsurgical endodontic retreatment requires an equilibrium between its sealer dissolution competency and clinical safety regarding toxicity and belligerence toward the tissues. The use of essential oils in endodontics is growing because of their safety, biocompatibility, and noncarcinogenicity. [1]

Eucalyptus oil is the distilled oil obtained from the leaves of *Eucalyptus globulus*; a plant of the family Myrtaceae native to Australia and cultivated worldwide. Its major constituent is 1,8-cineole. It exhibits antibacterial and anti-inflammatory properties.[1]

Orange oil, an extract of the peel of sweet orange fruit (*Citrus sinensis*) is an efficient alternative to potentially toxic solvents. Sweet orange oil consists of approximately 90% D-limonene; a solvent used in various household products. D-Limonene is an efficient cleaning agent with a pleasant smell and is considered environment friendly. There is no evidence for its carcinogenicity or genotoxicity. [1][3] Further, orange oil is less cytotoxic and more biocompatible than eucalyptol and chloroform. [6][17]

Xylene is a less toxic alternative to chloroform. It is commonly considered as an efficient solvent for several organic materials such as gutta percha (alkadienes; a hydrocarbon), polymers (resilons; a polycaprolactone), resins and sealers. [1] This may be due to its action on covalent bonds between the carbon atoms. Chloroform dissolves rather than softens the obturating materials, leaving residues on the canal walls and its fast evaporation makes use of more and more solvent, which makes its use messy and inconvenient. However, the action of xylene is relatively slow, which permits an efficient and biologically safe removal of softened filling materials. [3]

Sealapex differs from other root canal sealers in that it contains calcium hydroxide as a major constituent. The approximate composition, as stated by the manufacturer, is: calcium hydroxide, 25.0%; barium sulfate, 18.6%; zinc oxide, 6.5%; titanium dioxide, 5.1%; and zinc stearate, 1.0%, in a blend of ethyl toluene sulfonamide, poly (methylene methyl salicylate) resin, isobutyl salicylate, methyl salicylate, and a pigment. The material is claimed by its manufacturer to possess very low setting shrinkage and low solubility in tissue fluids, although no independent reports have been published to date. The present study examines one of the pertinent physical properties, namely, the ability to seal the root canal. [27]

AH26 is a resin based sealer, which provided significantly better apical seal on dye penetration

test in comparision with Apexit, Sealapex, and Tubli-Seal in the study by Limkangwalmongkol et al[26] in which sealing properties are combined with the findings of other studies. AH26 appears to have many advantages over other sealers. It mixes easily, flows well, has ample working time, good radiopacity, comparable solubility, good adhesion, and good biocompatibility. It has also been shown to adhere to dentin that has been maintained in a moist state. Of the materials tested in this study, AH26 had the best working characteristics. [26]

Endomethasone N is a zinc oxide eugenol-based sealer. It has been developed to ameliorate the neurotoxic and mutagenic effects of paraformaldehyde present in its predecessor. Its cytotoxicity is approximately 30 times lower than a formaldehyde-containing sealer.[18] This high degree of solubility is probably due to the release of eugenol, and the hydrolysis of hardened zinc eugenolate. ZOE-based materials decompose hydrolytically as follows: [19][1]

$$Zn(C_{10}H_{11}O_2)_2 + 2H_2O = Zn(OH)_2 + 2C_{10}H_{11}O_2$$

This zinc hydroxide is almost insoluble in neutral, but highly soluble in an acidic solution. [19]No significant difference was observed in the dissolution of zinc oxide–eugenol-based sealer (Endofill) by orange oil, chloroform, and eucalyptus oil in a scanning electron microscope retreatment study.[21] However, Whitworth and Boursin [8] observed that zinc oxide–eugenol-based sealer presented significantly lower solubility in halothane than chloroform, which was 9 times more effective than eucalyptus oil when exposed for 20 min.

In the present study, Xylene showed to be the most effective solvent for calcium hydroxide based sealer (sealapex), Orange oil was most effective for resin based sealer (AH 26) and Eucalyptus oil was most effective for Zinc Oxide based sealer (Endomethasone N).

According to Kumar et al in 2016, Endomethsaone showed a higher weight loss than other endodontic sealers and the maximum in xylene followed by orange oil and eucalyptus oil. This is in accordance with the previous studies [20][21] and contradictory to the present study.

According to Martos et all in 2011, Zinc oxide based sealer (Endomethasone N) had more solubility in eucalyptus oil at 10 min, and calcium hydroxide based (Sealer 26) had no significant differences but showed maximum solubility in xylol. [2] This results was in accordance to the present study. While resin based (Epiphany) had greater solubility in chloroform and epoxy resin based(EZ fill) had more solubility in xylol [2] contradicting the results in the present study. Kumar et al in 2016 showed that xylene was the best solvent for all the sealers used (Adseal, Apexit plus and Endomethasone N) [1] which holds accordance for the only Sealapex in the present study.

Schafer et al in 2002 reported that with the exception of the silicone, all the sealers showed significantly higher solubilities ($P < .05$) in chloroform than in eucalyptus oil. Epoxy resin (AH 26 and AH Plus) was the most soluble sealer in chloroform. In eucalyptus oil, calcium hydroxide (Apexit and Sealapex), and zinc oxide–eugenol based sealer (Aptal-Harz) showed the highest solubility[12] which showed similarity in solubility of Endomethasone N in the present study. Görduysus et al in 1997 reported that xylol showed similar behavior in dissolving gutta-percha as chloroform. [11]

The present laboratory investigation did not consider the clinically imposed parameters such as canal system anatomy, temperature, access, volume of exchange, dilution or displacement by biological fluids, or irrigants regarding the action of solvents on root canal sealing cement. Therefore, its result cannot be directly extrapolated to clinical scenarios. The search for more effective and biocompatible universal solvent should continue and should not be confined simply to the softening and gross removal of obturating materials.

CONCLUSION

Within the limitations of this in vitro study, the following conclusions had been drawn.

1. Xylene was the most effective solvent for calcium hydroxide based sealer.
2. Orange oil was most effective for resin based sealer.
3. Eucalyptus oil was most effective for Zinc Oxide based sealer used.

4. All the sealers showed more dissolution in all the solvents used at 10 min than 2 min
5. In distilled water, insignificant sealer dissolution was observed.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Hemant Kumar Yadav, Rakesh Kumar Yadav1, Anil Chandra1, Rahul Rameshbhai Thakkar; The effectiveness of eucalyptus oil, orange oil, and xylene in dissolving different endodontic sealers ; Journal of Conservative Dentistry 2016.

2. Martos J, Bassotto APS, Gonza´ lez-Rodrı´guez MP, Ferrer-Luque CM. Dissolving efficacy of eucalyptus and orange oil, xylol and chloroform solvents on different root canal sealers. International Endodontic Journal, 44, 1024–1028,2011.

3. Mushtaq M, Farooq R, Ibrahim M, Khan FY. Dissolving efficacy of different organic solvents on gutta-percha and resilon root canal obturating materials at different immersion time intervals. J Conserv Dent 2012;15:141-5.

4. Stabholz A, Friedman S. Endodontic retreatment: Case selection and technique. Part 2: Treatment planning for retreatment. J Endod 1988;14:607-14.

5. Ingle JI, Bakaland LK: Outcome of endodontic treatment and retreatment: Endodontics, 5th ed. Hamilton: BC Decker Inc; 2002. p. 747-68.

6. Zaccaro Scelza MF, Lima Oliveira LR, Carvalho FB, Côrte-Real Faria S. In vitro evaluation of macrophage viability after incubation in orange oil, eucalyptol, and chloroform. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:e24-7.

7. Vinothkumar TS, Deivanayagam K, Ganesh A, Kumar D. Influence of different organic solvents on degree of swelling of poly (dimethyl siloxane)-based sealer. J Conserv Dent 2011;14:156-9.

8. Whitworth JM, Boursin EM. Dissolution of root canal sealer cements in volatile solvents. Int Endod J 2000;33:19-24.

9. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod 2013;39:1281-6.

10. Flores DS, Rached FJ Jr., Versiani MA, Guedes DF, Sousa-Neto MD, Pécora JD. Evaluation of physicochemical properties of four root canal sealers. Int Endod J 2011;44:126-35.

11. Görduysus MO, Tasman F, Tuncer S, Etikan I. Solubilizing efficiency of different gutta-percha solvents: A comparative study. J Nihon Univ Sch Dent 1997;39:133-5.

12. Schäfer E, Zandbiglari T. A comparison of the effectiveness of chloroform and eucalyptus oil in dissolving root canal sealers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93:611-6.

13. De Oliveira DP, Barbizam JV, Trope M, Teixeira FB. Comparison between gutta-percha and resilon removal using two different techniques in endodontic retreatment. J Endod 2006;32:362-4.

14. Wong R. Conventional endodontic failure and retreatment. Dent Clin N Am 2004;48:265-89.

15. Kfir A, Rosenberg E, Tamse A, Tsesis I. Can epoxy resin based endodontic sealers be softened within 1-2 min? An *in vitro* study with chloroform and xylene. Endod Pract Today 2012;6:189-94.

16. Duncan HF, Chong BS. Removal of root filling materials: Root filling removal. Endod Topics 2008;19:33-57.

17. Magalhães BS, Johann JE, Lund RG, Martos J, Del Pino FA. Dissolving efficacy of some organic solvents on gutta-percha. Braz Oral Res 2007;21:303-7

18. Ersev H, Schmalz G, Bayirli G, Schweikl H. Cytotoxic and mutagenic potencies of various root canal filling materials in eukaryotic and prokaryotic cells *in vitro*. J Endod 1999;25:359-63.

19. Wilson AD. Specification test for the solubility and disintegration of dental cements: A critical evaluation of its meaning. J Dent Res 1976;55:721-9.

20. Martos J, Bassotto AP, Gonzalez-Rodriguez MP, Ferrer-Luque CM. Dissolving efficacy of eucalyptus and orange oil, xylol and chloroform solvents on different root canal sealers. Int Endod J 2011;44:1024-8.

21. Scelza MF, Coil JM, Maciel AC, Oliveira LR, Scelza P. Comparative SEM evaluation of three solvents used in endodontic retreatment: An *ex vivo* study. J Appl Oral Sci 2008;16:24-9.

22. Marin-Bauza GA, Silva-Sousa YT, da Cunha SA, Rached-Junior FJ, Bonetti-Filho I, Sousa-Neto MD, *et al.* Physicochemical properties of endodontic sealers of different bases. J Appl Oral Sci 2012;20:455-61. 15.

23. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod 2013;39:1281-6.

24. Shenoi PR, Badole GP, Khode RT. Evaluation of softening ability of Xylene and Endosolv-R on three different epoxy resin based sealers within 1 to 2 minutes – An *in vitro* study. Restor Dent Endod 2014;39:17-23.

25. Barbosa SV, Burkard DH, Spångberg LS. Cytotoxic effects of gutta-percha solvents. J Endod 1994;20:6-8.

26. Sriwalee Limkangwalmongkol, DDS, MDSc, Peter Burtscher, PhD, Paul V. Abbott, BDSc, MDS, FRACDS(Endo), Anthony B. Sandier, BDSc, HDDent, and Brian M. Bishop, MDS, MSc, BDS, LDSRCS, A Comparative study of apical leakage of four root canal sealers and laterally condensed gutta percha. Journal of endodontics, Vol. 17, No. 10, October 1991.

27. K. C. Lim, BDS, MSc, and Brian G. Tidmarsh, BDS, FRACDS, The Sealing ability of sealapex as compared to AH26. Journal of endodontics. Vol 12, No 12, December 1986.