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A COMPARISON OF EFFECTIVENESS OF DIFFERENT SOLVENTS IN DISSOLVING ROOT CANAL SEALERS - AN IN-VITRO STUDY

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ABSTRACT:

AIM: The aim of this study was to evaluate the dissolution effectiveness of Xylene, Endosolv, RC Solve and distilled water on three different endodontic sealers.

MATERIALS AND METHODS: The solubility of three types of root canal sealers (Sealapex, Endofill and AH-Plus) was assessed in Xylene, RC Solve, Endosolv and distilled water. A hundred and twenty samples of gutta-percha were prepared using a standardized stainless steel mould, filled with three sealer cements and subdivided into three groups for immersion in the different solvents tested (Xylene, RC Solve, Endosolv) and distilled water (control group) for 10 minutes immersion period. The means of gutta-percha dissolution in the solvents were obtained by the difference between the pre-immersion original weight and the post-immersion weight in a digital analytical scale (Gehaka – AG2000) and data were statistically analyzed.

RESULTS: Endosolv was the most effective solvent followed by Xylene in AH-Plus and Sealapex groups. RC Solve showed the best dissolving capacity in Endofill, followed by Endosolv and Xylene. In distilled water, insignificant sealer dissolution was observed in all groups.

Keywords : Solubility, Sealers, Organic solvents.

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INTRODUCTION

The major cause for the "failure" of primary endodontic therapy is the persistence of intra and extra-radicular microbial infections. Despite being highly successful, some endodontic treatments do not respond to initial therapy for different reasons and, hence, retreatment becomes necessary. In most cases, retreatment is indicated due to improper cleaning and filling or due to lack of an efficient hermetic sealing, which enables the survival of bacteria inside dentinal tubules, apical ramifications, accessory canals, and secondary canals.[1,2] Removal of endodontic filling material from the root canal is a requirement for retreatment.[3,4] Several methods for removing the filling material—including the use of solvents, heat, and mechanical instrumentation, either alone or in combination with each other—are available.[5] Gutta-percha, along with a variety of root canal sealers, is the most commonly used root canal filling material. It can be removed without great difficulty with the use of organic solvents or heated instruments.[5,6] However, the sealer may resist dissolution, and complete removal may vary considerably.[7]

Several commercially available endodontic sealers present different physicochemical characteristics, which could influence and consequently determine the clinical efficacy of any of the solvents.[7]

Organic solvents have been used for a long time as an auxiliary or principal method of gutta-percha removal, being the more effective chemical substances to dissolve the filling endodontic material. Chloroform and xylene are the two most commonly used solvents. Some studies have suggested chloroform as the most effective solvent for most filling materials.[8] It has been shown to have an excellent capacity for dissolution when compared to other solvents such as eucalyptol, xylol, or halothane, but the U.S. Food and Drug Administration prohibit chloroform because of its potential carcinogenicity.[9] Xylene is available nowadays for clinical use, and it is not considered a carcinogen, but is very

TABLE 1

S.no.	Sealer	COMPOSITION	
1	AH plus	Paste A: Bisphenol A epoxy resin, Bisphenol F epoxy resin, Calcium tungstate, Zirconium oxide, Silica, Iron Oxide Pigments	Paste B: Dibenzyldiamine, Amino-adamantane, Tricyclodecane-diamine, Calcium tungstate, Zirconium oxide, Silica, Silicone oil
2	ENDOFILL	Powder: Thymol Iodide 22.5%, Polyoxymethylene 2.2%, Hydrocortisone Acetate 1.0%, Dexamethasone Acetate 0.01%, excipient ad 100%	Liquid : Eugenol
3	SEALAPEX	BASE N-ethyl toluene solfanamide resin, fumed silica (silicon dioxide), zinc oxide, calcium oxide	CATALYST Isobutyl salicylate resin, fumed silica (silicon dioxide), bismuth trioxide, titanium dioxide pigment

Sealers	RC Solve	Xylene	Endosolv	Distilled Water
SEALAPEX	3.04±0.76	3.51±0.80	5.32±0.75	0.19±0.03
ENDOFILL	6.23±0.82	5.91±0.62	6.03±0.72	0.22±0.05
AH-PLUS	0.80±0.18	2.05±0.56	1.63±0.44	0.15±0.04

toxic to tissues. Gutta-percha is also soluble to essential oils.

Some of them have been reported as safe and useful for this purpose, like eucalyptus (eucalyptol) and pine tree (turpentine) essential oils.

Since it is important to use solvents that will not damage periapical tissues, the use of effective orange oil and its derivates were proposed for the disintegration of zinc-oxide–eugenol (ZnOE)-based sealers. According to Pécora *et al.* (1992), orange oil acts on gutta-percha in the same way

that xylol does, without presenting any deleterious effect of that.[10]

RC Solve liquid is a derivative of orange oil, indicated for dissolving gutta-percha and zinc-oxide eugenol cement. It does not irritate soft tissues or periapical areas. Additionally, it provides a pleasant orange fragrance and a slow rate of evaporation. Endosolv, a tetrachloroethylene softening solution, is a currently available synthetic endodontic solvent, which is designed to remove phenol-based resin sealers and zinc-oxide eugenol based sealers

The choice of an ideal solvent for endodontic retreatment requires a balance between clinical safety in usage (substances with low toxicity and aggressivity towards tissues) and the highest chemical capacity for dissolution.[11]

The study is based on the need for the removal of sealers from canal walls and apical ramifications using organic solvents for effective cleaning and disinfection. The aim was to compare the efficacy of three organic solvents i.e. Xylene, Endosolv and RC Solve, commonly used in endodontics in solubilizing different root canal sealers (Sealapex, Endofill and AH-Plus).

MATERIALS AND METHOD

Calcium hydroxide-based/Sealapex (Kerr, Karlsruhe, Germany), Epoxy resin based/AH Plus (Dentsply, DeTrey, Konstanz, Germany), and zinc-oxide eugenol-based/Endofill (Dentsply Maillefer, Ballaigues, Switzerland) sealers were used in this *in vitro* study. The compositions of the different sealers used in the study as given by the manufacturers are summarized in Table 1.

Standardized stainless steel molds, 8 mm in diameter and 2 mm in height, were used for the preparation of one hundred twenty sealer specimens. The samples were then divided into three equal groups (n=40) according to the sealers being used. Sealer cements were mixed in accordance with the manufacturers' instructions and introduced into the molds. A microscope slide covered with cellophane strip was then pressed onto the upper surface to make the surface flat. Ten minutes after mixing, the molds were then transferred to a humidifier with 80% relative humidity and 37±1° C temperature for 72 hours. Then they were removed from the chamber and excess material was trimmed to the surface level of the mold with a scalpel and brush. The samples were weighed in grams 3 times (up to four decimal places) on a digital analytical scale (Gehaka – AG2000) prior to immersion in the solvent to obtain the initial mass (m1).

Each group was then further divided into four equal subgroups (n=10) for immersion in the respective organic solvents for a 10 minute immersion period. The selected solvents were xylene (Fisher Scientific, Mumbai, India), Endolv (Septodont, New Castle, Delaware), RC Solve (Prime Dental Products pvt. Ltd., India). Distilled water served as a control. At room temp, all sealer samples were immersed completely in 10 ml of solvent stored in glass vials. After the specified immersion period of 10 min, the samples were removed from glass vial, rinsed with 100 ml of distilled water, and then blotted dry with absorbent paper. Samples were allowed to dry for 24 h at 37 ± 1°C in an incubator and then kept in dehumidifier for 15 minutes. Thereafter, they were weighed 3 times and the means were calculated (m2), and the amount of sealer lost from each specimen was determined was the difference between the mean of this measurement and the original weight of the sealer, using the following equation:

$m = m1 – m2$

where:

$m1$ = pre-immersion weight;

$m2$ = post-immersion weight.

The means and standard deviations of dissolution (weight loss) in grams were calculated at the specified immersion time interval for each group of specimens (Table 2). The values were compared by factorial analysis of variance (ANOVA) using SPSS 16.0 software (SPSS Inc., Chicago, IL, USA), and differences amongst the materials were calculated and multiple comparison tests performed to identify statistically homogenous subgroups (P<0.05) using a post hoc least significant difference test (LSD) with the value of statistical significance set at 0.05.

RESULTS:

The different solvents effect on Sealapex showed there was a significant amount of weight loss in all groups except the control group (p<0.05). Endosolv exhibited the best dissolving capability on Sealapex followed by Xylene and RC Solve. Distilled water exhibited almost negligible dissolution of any sealer.

The different solvents effect on Endofill showed that there was a insignificant amount of weight loss in all groups except the control group (p<0.05). RC Solve exhibited the best dissolving capability on this group followed by Endosolv and Xylene. The control group exhibited almost negligible dissolution.

The different solvents effect on AH Plus showed there was a significant amount of weight loss in all groups except the control group (P<0.05). Xylene exhibited the best dissolving capability on AH Plus followed by Endosolv and RC Solve. Distilled water exhibited almost negligible dissolution of any sealer.

TABLE 2:

Mean values with standard deviation for weight loss for each endodontic sealer in different organic solvents at 10 min.

DISCUSSION

Considering the great perspective of success in endodontic reinterventions, retreatment becomes a conservative clinical conduct in comparison with more radical procedures such as

periapical surgeries. Therefore, it is necessary to remove the obturation materials. Generally, endodontic instruments in combination with solvents are used to completely eliminate filling materials from the root canals [12] because the dangers of using purely mechanical means to remove root canal filling materials are root perforation, canal straightening, or altering the original canal shape. When an organic solvent is used during re-treatment, extrusion of the solvent into the periapical tissue should be prevented.[13]

Although there are no international standards for root canal sealer solubility in organic solvents, an International Organization for Standardization 6876:2001 is available that describes the procedure to determine the solubility of set sealer in water. According to the instructions given by this standard, ring molds should have an internal diameter of 20 mm and a height of 1.5mm.[13]

The use of organic solvents has been anticipated to decrease the resistance of obturating materials inside the canal so that their retrieval can become easier in synergism with instrumentation. 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.[12]

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.[13]

Under the experimental conditions of the present study, AH-Plus (an epoxy resin-based material) showed the lowest level of solubility than other sealers in all the solvents. It may be due to the fact that Epoxy resin (AH-Plus) is a heavily cross-linked, rigid, and strong polymer.[14] AH-Plus showed significantly higher dissolution in endosolv than xylene at 10 min followed by RC Solve. Use of Endosolv-R for removal of resin based sealer has suggested by Cohen, Duncan and Chong[15]. It contains 66.5 grams of formamide and 33.5 grams of phenyl ethylic alcohol.26 This solvent is able to soften conventional zinc oxide eugenol cements (Endosolv E) and phenolic resin type sealers (Endosolv R) in the context of endodontic retreatment. Setting of epoxy resin sealers involves polymerization and cross linking of their monomers, resulting in 3D lattice.[12] This set polymer is unaffected by saline or water. Hydrophobic organic solvents such as Xylene and Endosolv-R may have the ability to penetrate this 3D lattice resulting in swelling of the lattice and reduction in strength and hardness. Thus, softening occurs that facilitates their removal by scrubbing effect provided by files.[14] Ramzi et al.[16] have stated that Endosolv-R combined with rotary files has most effectively removed filling materials from the root canals, especially in the apical third. Gambrel et al.[17] concluded in their probe penetration study that softening effect of Endosolv-R after 20 minutes was superior to other tested solvents.[12] Shokubinejad et al.[18] mentioned that Endosolv-R does not affect the bond strength of newer obturation materials with root canal dentin whereas Laxmi Narayan et al. showed that Xylene causes significant reduction in enamel and dentin microhardness and thus may reduce the bond strength of newer endodontic sealers.[13] Even less information regarding biocompatibility of Endosolv-R is available and it has been suggested to have fetotoxic properties.[14] However, results mentioned in this study may vary in in-vivo conditions based on setting characteristics of sealer in root canal system and availability of solvents to the sealer in curved & ramified canals.

Endofill, a zinc-oxide eugenol based endodontic sealer that showed maximum weight loss out of all the sealers. It showed slightly higher weight loss in RC Solve, followed by Endosolv and xylene and least in distilled water. RC Solve, is a liquid for gutta pucha & Zinc Oxide cement dissolution. Liquid is derivative of orange oil which shall not irritate soft tissue or Periapical area, also offers pleasant orange fragrance. It does not evaporate as rapidly as chloroform or other solvents. Orange oil is an excellent alternative solvent compared to potentially toxic solvents, being used either on zinc-oxide eugenol cement or to soften and dissolve gutta-percha [19].

Xylene is chlorinated hydrocarbon commonly considered as gutta percha solvent. It is a benzene derivative and is commonly used to remove gutta perch and root canal sealers since it is milder solvent with a slow evaporation rate. It may also soften or dissolve the sealers and could potentially facilitate their mechanical removal. Xylene, dissolves root canal filling material more slowly, thus allowing better control and removal of softened rather than liquefied root canal filling material.[15] Xylene causes irritation of eyes and mucous membranes, gastrointestinal distress and toxic hepatitis when ingested, chemical pneumonitis, hemorrhages in air spaces when inhaled, cytotoxic reaction when extruded periapically. However Chutich et al.[20] have suggested that the amount of Xylene periapically extruded was too small to cause toxicity.

Sealapex, a calcium hydroxide-based sealer has a more convenient delivery form and hydrophilic formulation of Sealapex.[21] In this investigation, Sealapex had shown more pronounced dissolution in all the organic solvents as compared with distilled water.[22] It showed maximum dissolution in Endosolv followed by xylene and RC Solve and distilled water the least.

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.

CONCLUSION:

The use of essential oils in endodontics is growing because of their proven safety, biocompatibility and non-

carcinogenicity. Within the limitations of this in vitro investigation, we were able to conclude that:

– Xylene and Endosolv presented similar solvent effects, with a significant solubility of the tested cements. RC Solve presented a superior solvent effect as compared to other solvents only when compared to the control group in all sealers but it showed slightly higher dissolving ability that Endosolv and Xylene in the Endofill group.

– Sealapex and Endofill showed the maximum solubility in 10 minutes but with no significant difference amongst them, while AH Plus showed the least solubility amongst all sealers.

BIBLIOGRAPHY

1. Bergenholtz G et al (1992). Retreatment of endodontic fillings. Scand J Dent Res. 87:217–224.
2. De Deus QD (1975). Frequency, location and direction of the lateral, secondary and accessory canals. J Endod. 11:361–366.
3. Friedman S, Moshonov J, Trope M (1993). Residue of gutta-percha and a glass ionomer cement sealer following root canal retreatment. Int Endod J 26:169–172.
4. Mandel E, Friedman S (1992). Endodontic retreatment: a rational approach to root canal reinstrumentation. J Endod. 16:565–569.
5. Friedman S, Stabholz A, Tamse A (1990). Endodontics retreatment—case selection and technique. Part 3. Retreatment techniques. J Endod. 1990;16:643–649.
6. Oyama KON, Siqueira EL, Santos M. In vitro study of effect of solvent on root canal retreatment. Braz Dent J. 2002;13:208–211.
7. Moshonov J, Trope M, Friedman S. Retreatment efficacy 3 months after obturation using glass ionomer cement, zinc oxide–eugenol, and epoxy resin sealers. J Endod. 1994;20:90–92.
8. Erdemir A, Adanir N, Belli. In vitro evaluation of the dissolving effect of solvents on root canal sealers. J Oral Sci. 2003;45:123–126.
9. 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. 2002;93:611–616.
10. Pécora JD, Costa WF, Filho DS, Sarti SJ. Apresentação de um óleo essencial, obtido de Citrus aurantium, eficaz na desintegração do cimento de óxido de zinco–eugenol do interior do canal radicular. Odonto. 1992;1:130–132.
11. Schuurs AH, Moorer WR, Wesselink PR (2004). Solvents for the removal of gutta-percha from root canals. 2. Side effects of chloroform, halothane and xylene. Ned Tijdschr Tandheelkd. 2004;111:303–306.
12. Shenoi PR, Badole GP, Khode RT. Evaluation of softening ability of Xylene & Endosolv-R on three different epoxy resin based sealers within 1 to 2 minutes - an in vitro study. Restor Dent Endod. 2014 Feb;39(1):17-23.
13. Mushtaq M, Masoodi A, Farooq R, Yaqoob Khan F. The dissolving ability of different organic solvents on three different root canal sealers: in vitro study. Iran Endod J. 2012 Fall;7(4):198-202.
14. Martos J, Gastal MT, Sommer L, Lund RG, Del Pino FA, Osinaga PW. Dissolving efficacy of organic solvents on root canal sealers. Clin Oral Investig. 2006 Mar;10(1):50-4
15. Duncan HF, Chong BS. Removal of root filling materials. Endod Topic 2008;19:33–57.
16. Ramzi H, Shokouhinejad N, Saghiri MA, Samieefard A. Efficacy of three different methods in the retreatment of root canals filled with Resilon/Epiphany SE. Iran Endod J 2010;5:161–166.
17. Gambrel MG, Hartwell GR, Moon PC, Cardon JW. The effect of endodontic solution on resorcinol-formalin paste in teeth. J Endod 2005;31:25–29.
18. Shokouhinejad N, Sabeti MA, Hasheminasab M, Shafiei F, Shamshri AR. Push-out bond strength of resilon/epiphany self-etch to intraradicular dentin after retreatment: a preliminary study. J Endod 2010;36:493–496.
19. Nasim I, Neelakantan P, Subbarao CV. Effect of gutta-percha solvents on the bond strength of two resin-based sealers to root canal dentin. Acta Odontol Scand. 2014 Jul;72(5):376-9.
20. Chutich MJ, Kaminski EJ, Miller DA, Lautenschlager EP. Risk assessment of the toxicity of solvents of gutta-percha used in endodontic retreatment. J Endod 1998;24:213–216.
21. Lim KC, Tidmarsh BG. The sealing ability of Sealapex compared with AH26. J Endod. 1986 Dec;12(12):564-6.
22. Desai S, Chandler N. Calcium hydroxide-based root canal sealers: a review. J Endod. 2009 Apr;35(4):475-80.