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Effectiveness of Chloroform and Orange Oil as Gutta-percha Solvents used in Endodontic Retreatment: An *In Vitro* Study

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Abstract

The aim of this study was to assess and compare the effectiveness of chloroform and orange oil to dissolve obturated materials during endodontic retreatment. Thirty extracted human permanent maxillary anterior teeth (10 central incisor, 10 lateral incisor and 10 canine) which fulfilled specific inclusion criteria were de-coronated and after biomechanical preparation using step-back technique obturated with gutta-percha and AH plus sealer and stored in 37^0C in 100% humidity for 2 weeks. Then the teeth were assigned into 2 groups randomly: Chloroform (n= 15) and Orange oil (n= 15). Solvents were applied to reservoir created on the coronal root third for 2 minutes. Then instrumentation was initiated to remove obturated materials using Hedstrom file until the master apical file size 40 for central incisor and canine and 35 for lateral incisor reach the working length. The time to reach the working length and the time to obtain the last debris were recorded. Data were collected and analyzed by using SPSS version 22. The results showed no statistically significant difference (P>0.05) between two gutta-percha solvent groups in relation to time required to reach the working length by master apical file and time required to remove total obturated material from root canal. In conclusion, there was no statistically significant difference in effectiveness between chloroform and orange oil as gutta-percha solvent during retreatment procedure. So, orange oil can be used in retreatment procedure with the same efficacy of chloroform to dissolve obturated material in the root canal.

Keywords: Gutta-percha, Chloroform, Orange Oil, Endodontic Retreatment

Introduction

Retention of natural teeth in asymptomatic clinical condition is one of the main goals of endodontic therapy. Endodontic treatment is a dental procedure in which damaged pulp of a tooth is removed and pulp space is filled with an inert material like gutta-percha and sealer. Although the success rate of endodontic treatment reached the level of 86% to 93% [1], failures in most cases are associated with undesirable root canal system cleaning or filling that induce to the retreatment [2, 3], Usually retreatment is first choice because this procedure allows a greater longevity of dental element in the oral cavity [3]. The retreatment is the repetition of a primitive incorrect endodontic treatment to remove all the filling materials from the root canal system and to perform a new correct treatment [4, 5]. Endodontic retreatment is of 2 types- non-surgical or conventional retreatment and surgical retreatment. Non-surgical endodontic retreatment requires complete removal of pre-existing endodontic filling material usually made by the association of gutta-percha and some endodontic cement as sealer from the root canal space and disinfection of the root canal system and again filling the root canal. Surgical retreatment is the choice when the proper non-surgical therapy is not possible or has already failed.

Studies have reported that it is essential to remove all root canal filling material from root canal system to ensure cleaner root canal walls [6]. This facilitates the chemo-mechanical preparation and antimicrobial dressing to access all ramifications of the entire root canal system during retreatment and decrease the residual microbial population [5, 6, 7, 8, 9]. And favors condition for new filling.

Numerous techniques are available for removing root canal obturating materials such as ultrasonic technique [10]. Stainless steel hand files (K-file and H-file), gates-glidden drills, heated pluggers [11], and presently many different rotary retreatment systems. Now a days, laser is also recommended for gutta-percha removal [12]. In order to remove filling materials without damage to the tooth, chemical solvents are used to solubilize the gutta-percha [13, 14, 15]. Organic solvents have to be applied during retreatment with aim to reduce the resistance of filling materials inside the root canal [16]. Thus facilitating their removal [4].

An ideal gutta-percha solvent requires the following properties; high solvent effect, low surface tension, easy to use, quick action and long life. During a retreatment, when the filling material is unknown, it is very important to have the different kinds of solvents at disposal, in order to use the most effective one [17]. Among chemical solvents chloroform, xylene, eucalyptus oil and orange oil have been more commonly used [18, 19, 20, 21]. Chloroform has been used as gutta-percha solvent since 1850 [22]. It is one of the most widely used solvents, because of its efficiency. It is also known as trichloromethane (CHCl3) and it is an organic solvent extremely effective in dissolving the gutta-percha. It is widely used in dental practice for its properties: Fast action, simplicity in use, low cost. Chloroform, however, can produce cytotoxic effects on periapical tissues and should be used with caution [23, 24]. On the other hand, orange oil was initially presented as an essential oil disintegration solvent of zinc oxide eugenol sealer [21]. Pecora *et al*. Reported that orange oil also softened gutta-percha cones in endodontic retreatment and could be used as solvent with good solvency feature and biocompatible to the periapical tissues without any deleterious effects [21]. Orange oil can also be used for the removal of epoxy resin-based sealer and calcium hydroxide-based sealer [25]. But previous studies have been inconclusive regarding the efficacy of chloroform and orange oil as gutta percha solvents. Magalhaes *et al*. Reported that the relative efficiency of chloroform and orange oil for dissolving gutta- percha had no significant difference [26]. Gustavo *et al*. And Almeida *et al*. Reported that chloroform presents the greatest ability to dissolve gutta percha than other solvents [27, 28]. On the other hand, Onaga *et al*. reported that the orange oil was better in softening gutta percha than chloroform [29].

Furthermore, regarding the retreatment strategies, although many endodontic retreatment studies have been reported, little clinical data are available regarding the time required to keep root canals soaked in solvents during retreatment.

Materials and methods

Thirty freshly extracted human permanent maxillary anterior teeth including 10 central incisors, 10 lateral incisors and 10 canines were selected according to inclusion and exclusion criteria. The teeth were cleaned and stored in a saline solution before instrumentation. Radiographic evaluation was done to check the canal patency. Then teeth were decoronated up to the cementoenamel junction using diamond disc. Canal lengths were established visually by placing a size 10 K-file into each root canal until the tip of the file was visible at the apical foramen and then the working length was established at 1 mm short of this position. The working length for central incisors and lateral incisors were 12 mm and for canines was 16 mm. The roots were placed in acrylic mold for standardization. Then the biomechanical preparation of the canal systems was done according to conventional step-back technique using K-files (Dentsply, Switzerland). The master apical file for central incisor and canine root canal was size 40 K-file and for lateral incisor was size 35 K-file. The coronal third of the roots were flared using a size 2 and 3 Gates Glidden drill. During preparation, root canals were irrigated with 2 ml of 5.25% NaOCl at each change of instrument. A size #10 k-file were used to establish patency following irrigation. When instrumentation was completed, final irrigation with 17% EDTA for 1 min was done to remove smear layer followed by rinsing with 3 ml of normal saline solution for each root canal. Then the canals were dried with paper point (Dentsply, Germany) before obturation. The root canals were obturated with gutta-percha and AH plus sealer (Dentsply, Germany) using cold lateral compaction technique. Master gutta-percha cone size 40 was selected for central incisor and canine and 35 was selected for lateral incisor and tug back was checked. The fit of the master cone was verified by radiograph. AH Plus sealer was mixed according to the manufacturer's instruction. The master cone was coated with sealer and positioned into the canal. Thereafter, accessory gutta-percha cones sizes 20 were laterally compacted using nickel-titanium (NiTi) finger spreader size 20, until the spreader could not be introduced more than 5 mm into the canal. Excess gutta-percha was removed at the canal entrance with heated instrument. Then the coronal access cavities of specimen were filled with Zinc oxide eugenol filling. Radiograph (RVG) of each specimen was taken to ensure homogeneity of root canal obturation, lack of voids and proper length of root canal filling material in both buccolingual and mesiodistal views by a single operator. Then the specimens were stored at 37^0 C in 100% humidity for 2 weeks to allow sealer to set completely. After 2 weeks the teeth were assigned into 2 groups according to the solvent employed by simple random sampling by lottery:

Chloroform (5 central incisors, 5 lateral incisors and 5 canines)

Orange oil (5 central incisors, 5 lateral incisors and 5 canines).

All roots were again placed in acrylic resin mold and temporary fillings were removed using size 2 round bur. A No 3 Gates-Glidden drill (Mani Inc, Japan) was used to remove the coronal 2 mm of the root canal filling to create reservoir for gutta-percha solvent. 0.4ml of chloroform (Obtusol, HAI Dental, Bangladesh) was delivered in group I and 0.4ml of orange oil (RC Clean, Pyrax Polymars, India) was delivered in group II to each sample reservoir with an insulin syringe. After 2 minutes, to allow for solvent penetration, re-instrumentation was initiated to remove gutta-percha and sealer using Hedstrom file. Size 20 H-file was placed in the canal to penetrate the root filling and remove the gutta-percha and sealer in a circumferential quarter-turn push-pull filing motion. The procedure was repeated with 25, 30, 35 and 40 no. H-file and gutta-percha solvent progressively. Every 30 seconds canal debris was removed by rinsing with 2 ml of 5.25% NaOCl using a 30-

gauge irrigation needle before adding solvents. Total 1 ml of each Solvent was used for each root canal. The endpoint of instrumentation was determined when the master apical file ISO #40 k-file was reached the working length for central incisor and canine and # 35 k-file for lateral incisor. The time required to reach the working length was recorded for each specimen by stopwatch. Retreatment was deemed complete when no more filling materials or sealer was seen on the last instrument. The total time required to remove total obturated materials was also recorded by stopwatch. Only the instrumentation time was recorded. The statistical analysis of results was done by using Statistical Package for Social Science (SPSS) version 22.

Results

The means of the time required to reach the working length in each group is shown in Table I. No significant difference (P> 0.05) was found regarding the time required to reach the working length between two solvents groups. The means of time required to remove the total obturated materials of min in each group is shown in Table II. No significant difference (P> 0.05) was found regarding the time required to remove total obturated materials between chloroform and orange oil groups.

Table I: Means of the time required to reach the working length between two solvent groups (n=15)

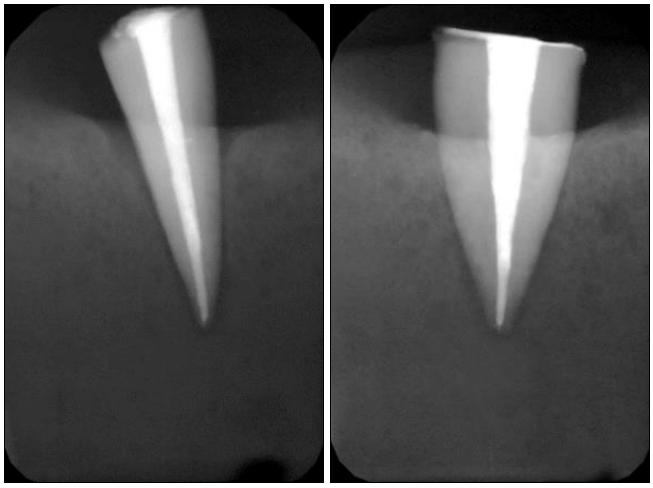
Groups of teeth	Chloroform Group (n=15)	Orange oil Group (n=15)	*P* Value
	Mean±SD	Mean±SD	
Central Incisor	7.15±1.32	8.26±0.65	0.117^{ns}
Lateral Incisor	10.75±0.81	9.83±1.01	0.251^{ns}
Canine	6.42±0.54	6.18±0.71	0.602^{ns}

ns= not significant
P value reached from Mann-Whitney U test

Table II: Means of the time required to remove the total obturated material between two solvent groups (n=15)

Groups of teeth	Chloroform Group (n=15)	Orange oil Group (n=15)	*P* Value
	Mean±SD	Mean±SD	
Central Incisor	9.72±2.08	10.60±1.32	0.548^{s}
Lateral Incisor	15.74±1.21	14.75±0.87	0.465^{s}
Canine	8.59±0.35	8.71±0.4	0.530^{s}

ns= not significant
P value reached from Mann-Whitney U test



Labio-palatal view **Mesio-distal view**

Fig 1: Post-obturation image

Discussion

The result of this study confirmed that there was no significant difference between the efficacy of chloroform and orange oil (used as gutta-percha solvents) in dissolving the obturated material in the root canal for retreatment of maxillary anterior teeth (central incisors, lateral incisors and canines). Furthermore, the required time to reach up to the working length as well as the removing ability of the obturated material from the root canal does not differ significantly.

The results and methodology found in the present vitro study have similarities and dissimilarities with some of the previous studies. At first, when the time required to reach the working length by master apical file was compared with the previous study, the present study does not show no any significant differences between chloroform and orange oil. This is also supported by Hansen who used chloroform and orange oil as solvent and found that there was no statistically significant difference of time required to penetrate the prefixed length by H-file [30].

Oyama *et al*. In their vitro study found that, there was statistically significant difference between chloroform and orange oil in softening gutta-percha [29]. This result is not similar to our study. It may be due to the use of different study procedure in which they measured the penetration force for a digital spreader with a constant speed to penetrate a prefixed depth into the gutta-percha in simulated canals in desired time where a 4442 Instron apparatus was used to generate the force. They also showed that orange oil required smaller amount of force than chloroform to penetrate the length in the desired time. However, in the present study, we avoid the application of any force because it was not necessary.

Furthermore, the completion of root canal retreatment was verified according to the total removal of obturated material from the root canal. Betti *et al*. also confirmed that, there was no evidence of gutta-percha or sealer on the files or paper points [31]. However, the time required for the endodontic retreatment, specially the time required to remove the obturated material during retreatment is not yet established. Ring J *et al*. In their study showed that the ability of chloroform and orange oil was almost similar but time required to remove obturated material was more in chloroform group than the orange oil group [32]. It may be due to the use of two types rotary retreatment file systems along with two solvents. This result and methodology is quite dissimilar with the present study.

Various studies were conducted to compare the dissolving capacity of chloroform and orange oil as gutta-percha solvent over time, where the study procedure was quite different from our study. To assess the solvency, some studies use the methodology of filling material immersion in solvents. In such type of study, Almeida *et al*. Found that chloroform showed the better dissolving capacity than orange oil [28]. The same study procedure was used by Magalhaes *et al*. [26] In that study they showed that, chloroform had the same efficacy as the orange oil.

The result of the present vitro study is an agreement with other study by Hunter *et al*. Which evaluated weight loss of gutta-percha in grams over time and concluded that there was no significant difference between chloroform and orange oil [18]. On the other hand, Tamse *et al*. [17] observed significantly less dissolution efficacy of orange oil than chloroform. This study created the dissimilarity with the

current study and it may be due to the procedural differences.

Scelza *et al*. [33] in their vitro study used maxillary canine teeth because of their straight canal and round anatomic shape, which would facilitate the removal of filling material. Similarly, Horvath *et al*. also used extracted human maxillary incisors and canine teeth in their study [35]. In this present study, we also used maxillary anterior teeth including central incisor, lateral incisor and canine teeth to simulate the clinical situation. But, Rehman *et al*. in their study used teeth with canal curvatures ranged from 2^0 to 40^0 [36]. There was no significant effect of canal curvature on removal of gutta-percha with chloroform and orange oil solvents in that study. This result was similar with our study.

Conclusion

There is no significant difference between the effectiveness of chloroform and orange oil in gutta-percha and sealer removal during retreatment. So, chloroform and orange oil can be used as an effective alternative to each other.

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References

1. Ng YL, Mann V, Gulabivala K. Tooth survival following non-surgical root canal treatment: A systematic review of the literature. International Endodontic Journal. 2010; 43(3):171-189.
2. Nair PN. On the causes of persistent apical periodontitis: A review. International Endodontic Journal. 2006; 39(4):249-281.
3. Torabinejad M, Anderson P, Bader J, Brown LJ, Chen LH, Goodacre CJ, *et al*. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: A systematic review. The Journal of Prosthetic Dentistry. 2007; 98(4):285-311.
4. Taşdemir T, Yildirim T, Çelik D. Comparative study of removal of current endodontic fillings. Journal of endodontics. 2008; 34(3):326-329.
5. Stabholz A, Friedman S. Endodontic retreatment—case selection and technique. Part 2: Treatment planning for retreatment. Journal of Endodontics. 1988; 14(12):607-614.
6. Ezzie E, Fleury A, Solomon E, Spears R, He J. Efficacy of retreatment techniques for a resin-based root canal obturation material. Journal of Endodontics. 2006; 32(4):341-344.
7. Chohayeb AA. Comparison of conventional root canal obturation techniques with Thermafil obturators. Journal of endodontics. 1992; 18(1):10-12.
8. Whitworth JM, Boursin EM. Dissolution of root canal sealer cements in volatile solvents. International Endodontic Journal. 2000; 33(1):19-24.
9. Wilcox LR, Krell KV, Madison S, Rittman B. Endodontic retreatment: Evaluation of gutta-percha and sealer removal and canal reinstrumentation. Journal of Endodontics. 1987; 13(9):453-457.
10. Krell KV, Neo J. The use of ultrasonic endodontic instrumentation in the re-treatment of a paste-filled endodontic tooth. Oral Surgery, Oral Medicine, Oral Pathology. 1985; 60(1):100-102.
11. Tachinami H, Katsuumi I. Removal of root canal filling materials using Er: YAG laser irradiation. Dental Materials Journal, 2010, 1005180017-.
12. Kimura Y, Wilder-Smith P, Matsumoto K. Lasers in endodontics: A review. International Endodontic Journal. 2000; 33(3):173-185.
13. Barbosa SV, Burkard DH, Spångberg LS. Cytotoxic effects of gutta-percha solvents. Journal of endodontics. 1994; 20(1):6-8.
14. Barletta FB, Lagranha SB. Análisis comparativo *in vitro* de diferentes técnicas de desobturación de conductos radiculares. Endodoncia. 2002; 20(6):189-196.
15. Chutich MJ, Kaminski EJ, Miller DA, Lautenschlager EP. PC 20 Risk evaluation of gutta-percha solvents in endodontic retreatment. Journal of Endodontics. 1995; 21(4):236.
16. Bodrumlu E, Er O, Kayaoglu G. Solubility of root canal sealers with different organic solvents. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2008; 106(3):e67-9.
17. Tamse A, Unger U, Metzger Z, Rosenberg M. Gutta-percha solvents—a comparative study. Journal of Endodontics. 1986; 12(8):337-339.
18. Hunter KR, Doblecki W, Pelleu Jr GB. Halothane and eucalyptol as alternatives to chloroform for softening gutta-percha. Journal of Endodontics. 1991; 17(7):310-312.
19. Kaplowitz GJ. Evaluation of the ability of essential oils to dissolve gutta-percha. Journal of Endodontics. 1991; 17(9):448-449.
20. Ladley RW, Campbell AD, Hicks ML, Li SH. Effectiveness of halothane used with ultrasonic or hand instrumentation to remove gutta-percha from the root canal. Journal of Endodontics. 1991; 17(5):221-224.
21. PECORA JD. *In Vitro* Study on the Softening of Gutta-Percha Cones in. Braz Dent J. 1993; 4(1):43-47.
22. Wourms DJ, Campbell AD, Hicks ML, Pelleu GB. Alternative solvents to chloroform for gutta-percha removal. Journal of Endodontics. 1990; 16(5):224-226.
23. Poggio C. Gutta-percha solvents alternative to chloroform: An *in vitro* comparative evaluation. EC Dent Sci. 2017; 15:51-56.
24. Kazi FM, Asghar S, Fahim MF. Dissolving Efficacy of Different Endodontic Solvents for Gutta Percha with Varying Time Intervals. J Pak Dent Assoc. 2018; 27:110-114.
25. Mushtaq M, Masoodi A, Farooq R, Khan FY. The dissolving ability of different organic solvents on three different root canal sealers: *In vitro* study. Iranian Endodontic Journal. 2012; 7(4):198.
26. Magalhães BS, Johann JE, Lund RG, Martos J, Del Pino FA. Dissolving efficacy of some organic solvents on gutta-percha. Brazilian oral research. 2007; 21(4):303-307.
27. Rubino GA, Akisue E, Nunes BG, Gavini G. Solvency capacity of gutta-percha and resilon using chloroform, eucalyptol, orange oil or xylene. J Health Sci Inst. 2012; 30(1):22-25.
28. de Almeida Gomes F, Daniel AP, Nunes RA, Fernandes AL, Maniglia-Ferreira C, de Matos HR, *et al*. Efficacy of gutta-percha solvents used in endodontic retreatments. RSBO Revista Sul-Brasileira de Odontologia. 2013; 10(4):356-361.

29. Hansen MG. Relative efficiency of solvents used in endodontics. Journal of endodontics. 1998; 24(1):38-40.
30. Oyama KO, Siqueira EL, Santos MD. *In vitro* study of effect of solvent on root canal retreatment. Brazilian Dental Journal. 2002; 13(3):208-211.
31. Betti LV, Bramante CM. Quantec SC rotary instruments versus hand files for gutta-percha removal in root canal retreatment. International Endodontic Journal. 2001; 34(7):514-519.
32. Ring J, Murray PE, Namerow KN, Moldauer BI, Garcia-Godoy F. Removing root canal obturation materials: A comparison of rotary file systems and re-treatment agents. The Journal of the American Dental Association. 2009; 140(6):680-688.
33. Scelza MF, Coil JM, Maciel AC, Oliveira LR, Scelza P. Comparative SEM evaluation of three solvents used in endodontic retreatment: An ex vivo study. Journal of Applied Oral Science. 2008; 16(1):24-29.
34. Imura N, Zuolo ML, Ferreira MO, Novo NF. Effectiveness of the Canal Finder and hand instrumentation in removal of gutta-percha root fillings during root canal retreatment. International Endodontic Journal. 1996; 29(6):382-386.
35. Horvath SD, Altenburger MJ, Naumann M, Wolkewitz M, Schirrmeister JF. Cleanliness of dentinal tubules following gutta-percha removal with and without solvents: A scanning electron microscopic study. International Endodontic Journal. 2009; 42(11):1032-1038.
36. Rehman K, Khan FR, Aman N. Comparison of orange oil and chloroform as gutta-percha solvents in endodontic retreatment. The Journal of Contemporary Dental Practice. 2013; 14(3):478.