



Comparison of Orange Oil and Chloroform as Gutta-Percha Solvents in Endodontic Retreatment

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ABSTRACT

Objective: To compare the efficacy of gutta-percha removal achieved with simple mechanical technique using two different solvents.

Materials and methods: It was an *in vitro* experimental study conducted at the Aga Khan University Hospital, Karachi, Pakistan on 27 extracted human molars divided into two groups by alternate sampling technique.

The teeth were prepared by manual filing and obturated with gutta-percha and calcium hydroxide sealer. Two drops of the assigned solvent were placed on the orifice of the obturated canal and Gates Glidden drills #1, 2 and 3 were used for removal of coronal gutta-percha. Manual filing was done for removal of remaining gutta-percha and the solvent was used in drops until needed. Postoperative periapical radiographs were taken to visualize the remaining gutta-percha left in the canals.

Descriptive statistics (mean and SD) of the variables such as tooth type, obturation length and canal curvatures were determined. Chi-square and independent sample t-tests were applied and level of significance was set at 0.05.

Results: There was 5.19 (3.8) mm of remaining gutta-percha in the orange oil group and 5.37 (4.2) mm in the chloroform group ($p = 0.90$).

Conclusion: There is no statistically significant difference between the orange oil and chloroform when used as solvent for removing gutta-percha.

Keywords: Gutta-percha, Retreatment, Endodontic solvents.

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INTRODUCTION

Root canal retreatment is often required when primary endodontic treatment has failed,¹ with the incidence being as high as 61% of previously treated teeth.² Because of the

increasing demand to preserve teeth, including cases with post-treatment disease following primary root canal treatment, there is a growing interest in conventional retreatment. The procedure requires the removal of the existing root filling, further instrumentation, disinfection and refilling.³ Successful removal of gutta-percha and sealer is an important step during retreatment; therefore removing the maximum amount of filling material from inadequately prepared and/or filled root canal systems appears to be essential in order to uncover remaining necrotic tissue or bacteria that may be responsible for persistent disease. Thorough chemomechanical reinstrumentation and re-disinfection of the root canal system is therefore essential.²

Various methods are used to remove the filling material, which are broadly classified into thermal, mechanical, chemical and a combination of the three. Methods using solvents for gutta-percha removal have been evidence based and well documented in literature.

Retreatment therefore requires complete removal of previous root filling material to facilitate proper cleaning, disinfection, shaping and refilling of the root canal system. Studies have reported that it is essential to remove all root canal filling material from anatomic ramifications and dentinal tubules to ensure cleaner root canal walls.⁴⁻⁶ This facilitates chemomechanical preparation, thorough irrigation and antimicrobial dressing to access all ramifications of the entire root canal system during retreatment and decrease the residual microbial population. In spite of all different retreatment strategies, studies have shown that it is not possible to obtain root canal walls completely free of debris and residual infection.^{7,8}

In order to remove filling materials without damage to the tooth, chemical solvents are used to solubilize gutta-percha. Orange oil, eucalyptol, xylol, chloroform, halothane, and rectified turpentine have all been used as adjuncts to

remove endodontic filling materials.⁹ The removal of root filling material can be achieved with endodontic hand files, engine-driven rotary instruments, ultrasonic instruments, heat carrying devices and more recently lasers. Furthermore, solvents can be used to soften and dissolve gutta-percha in the root canal to facilitate its removal and penetration of manual and rotary instruments as well as endodontic irrigants.

Most of the current methods for gutta-percha removal in practice today include use of hand files, Gates Glidden drills and rotary files with or without solvents. The most commonly used solvents in the past were chloroform, eucalyptol and turpentine oil. Chloroform being the gold standard due to its effectiveness in dissolving and removing maximum gutta-percha in a minimum time has been widely used. However, it is classified as a group 2B carcinogen by the International Agency for Research of Cancer.¹⁰ Studies have confirmed that substances placed in the pulp chambers of teeth have access to the periapical tissues and to the circulatory system through the periodontal vasculature. In spite of its excellent clinical performance chloroform was shown to have a high toxicity and be a potential carcinogen and therefore in 1976, the US Food and Drug Administration (FDA) banned the clinical use of chloroform in drugs and cosmetics because of a report of suspected carcinogenicity.¹¹ There was no associated ban on its use in dentistry; however, the report did result in the search for alternatives but none of them proved to be as effective as chloroform.¹²

In a recent study, orange oil was found to be more biocompatible than chloroform and eucalyptol.¹² In another study orange oil performed equally to chloroform and eucalyptol.¹³ The purpose of this study was therefore to compare the effectiveness of orange oil and chloroform in gutta-percha removal during endodontic retreatment on human extracted permanent teeth.

MATERIALS AND METHODS

Sample Size

Jörg F Schirrmeister et al¹⁴ in their study used 60 teeth and divided them into four groups of 15 teeth each, reporting that remaining filling material with H-files was 4.18 (2.01) mm, mean and SD respectively. In another study conducted by Abdulhamied Saad et al¹⁵ 60 teeth were selected and divided into three groups of 20 each and they reported that when hand files were used in retreatment, the remaining filling material in the canal was 10.24 (4.87) mm, mean and SD respectively. Keeping this difference, the World Health Organization sample size calculator¹⁶ was used. At 80% power and α at 5% (level of significance) the sample size turned out to be 11 teeth in

each group. We inflated the sample size by 20% to get at least 13 teeth in each group.

Methodology

An *in vitro* experimental study was conducted at the Aga Khan University Hospital Dental Clinics from August to December 2011 on 27 extracted maxillary and mandibular molars. All the teeth were scaled, cleaned and stored in sodium hypochlorite for 7 days, followed by washing, cleaning and storing in distilled water at room temperature for the remainder of the study period. The teeth were embedded in blocks of wax for standardization. Access cavities were prepared and preoperative periapical radiographs were taken, canals were located, cleaned and shaped with manual filing up to ISO #30 H-files with circumferential quarter turn push-pull filing movements at full working length followed by a step back technique up to ISO #55 H-file. The canals were then obturated with gutta-percha and calcium hydroxide sealer and intermediate periapical radiographs were taken by a single operator. The teeth were then stored in distilled water for 4 weeks.

The teeth were divided into two groups using alternate allocation:

Group A → 14 teeth → chloroform

Group B → 13 teeth → orange oil

Two drops of the assigned solvent were placed on the orifice of the obturated canal and Gates Glidden drills #1, 2 and 3 were used for removal of coronal gutta-percha. The canal was reinstrumented using H-files in a circumferential quarter-turn push-pull filing motion for removal of remaining gutta-percha and the solvent was used in drops until needed.

A maximum of 2 ml solvent was used for each tooth. Irrigation with 5 ml of sodium hypochlorite and 5 ml of distilled water was done in between the filing procedures for removal of debris. Filing and irrigation were repeated until no more gutta-percha was visible on retrieval of the files from the canals. Postoperative periapical radiographs were taken to visualize gutta-percha left in the canals (Fig. 1).

Length of obturated canals in mm and curvature of the canals in degrees were calculated using the VixWin Pro radiographic imaging software. Variables examined and recorded were: canal curvature (in degrees), length of canal obturated (mm), length of remaining gutta-percha (mm), location of remaining gutta-percha (coronal apical or middle third of the canal), grading according to Hulsman and Slotz Scale,¹⁷ gutta-percha extrusion through the apex (yes/no). SPSS version 19.0 was used for data analysis. Mean and standard deviation of quantitative variables and frequency



Fig. 1: pre- and postoperative radiographs of one of the study teeth

distribution of categorical variables were computed. Independent sample t-test was used for comparison of means of the two groups while Chi-square test was applied for categorical variables.

Residual gutta-percha was also evaluated using the Hulsman and Slotz¹⁷ scale. Hulsman and Slotz in their study in 1997 divided the remnant gutta-percha into six classes:

- Class I: No root canal filling material
- Class II: One to 3 small isles (<2 mm long) of root canal filling material
- Class III: More than 3 small isles (<2 mm long) of root canal filling material
- Class IV: One large piece (>2 mm long) of root canal filling material
- Class V: Root canal filling material >5 mm long
- Class VI: Several isles of root canal filling material >2 mm long.

RESULTS

There were 14 molars in the chloroform group (5 maxillary and 9 mandibular) and 13 molars in the orange oil group (4 maxillary and 9 mandibular).

The length of the obturated canals in the orange oil group was 10.9 ± 3.4 mm compared to 12.6 ± 1.9 mm in the chloroform group. The difference was not statistically significant.

Mean and SD of canal curvatures in the two groups were $23.3 \pm 7.7^\circ$ and $22.6 \pm 8.7^\circ$ respectively. There were no statistically significant differences between the two groups.

There was 5.19 (3.8) mm of remaining gutta-percha in the orange oil group and 5.37 (4.2) mm in the chloroform group with a p-value of 0.90.

Only two of the 27 teeth showed extrusion of gutta-percha and both were from the chloroform group.

DISCUSSION

Endodontic retreatment has largely replaced periradicular surgery for the management of failed root canal treatment.^{18,19} Most studies on retreatment are done *in vitro*, so that the amount of gutta-percha removal can be evaluated using radiographs, sectioning the teeth and doing a histological examination or SEM evaluation methods.

The curvature of canals was calculated to see if there was any effect of root canal curvature on amount of remaining gutta-percha and the two study groups were similar in this attribute. Canal curvatures ranged from 2° to 40° . There was no significant effect of canal curvature on remaining gutta-percha with either of the two solvents.

All retreatment techniques leave some remaining gutta-percha inside the canal.¹⁵ This finding confirms previous results reported by numerous investigators using different retreatment instruments, techniques and solvents.^{1,3} Similar findings were seen in our study wherein both groups showed remnant gutta-percha in all teeth except one in the orange oil group which showed no radiodensity in the canal.

Chloroform and orange oil were two tested solvents in the present study; results showed that there were no significant differences between the two solvents in dissolving gutta-percha. This is in agreement with other studies which evaluated weight loss of gutta-percha in grams

Table 1: Location of remaining gutta-percha in the coronal middle and apical thirds of the canal

Tooth no.	Remaining gutta-percha			
	Coronal	Middle	Apical	
1.	+	+	+	Chloroform
2.	+	-	+	
3.	+	+	+	
4.	+	+	+	
5.	-	+	-	
6.	+	+	-	
7.	-	+	-	
8.	+	+	-	
9.	-	+	+	
10.	+	-	+	
11.	-	-	+	
12.	+	+	-	
13.	+	+	+	
14.	-	-	+	
15.	-	-	-	Orange oil
16.	+	+	+	
17.	+	+	+	
18.	-	+	+	
19.	+	-	-	
20.	-	+	+	
21.	-	-	+	
22.	+	+	+	
23.	+	+	-	
24.	+	+	+	
25.	+	+	+	
26.	+	+	+	
27.	+	+	+	



Table 2: Grading of remaining gutta-percha according to Hulsmann and Stotz scale (n = 27)

Grade group	No. remaining GP	1-3 small isles <2 mm	More than 3 small isles <2 mm	Large piece >2 mm	Large piece >5 mm	Several isles >2 mm	Total	p-value (chi-square test)
Orange solvent	1	6	1	1	2	4	14	0.760
Chloroform	0	2	0	1	2	7	13	
Total	1	8	1	2	4	11	27	

over time and concluded that there was no significant difference between chloroform and orange oil and therefore orange oil is a safe and more biocompatible alternative to chloroform.^{12,13,20,21}

Apically directed pressure, used to facilitate file and solvent penetration, may contribute to the amount of apically extruded debris. This debris may cause irritation to the periradicular tissues and disturb healing.^{2,9} Extrusion of gutta-percha through the apex was another variable recorded in the present study and it was noted that only 2 teeth showed apical extrusion, and both were from the chloroform group. This is not a widely studied variable and its significance in the present study cannot be tested due to the small sample size, but it can be recommended for research using different solvents. Extrusion is explained by the fact that chloroform dissolves and breaks down gutta-percha into small isles of less than 2 mm making it too soft and flowable to be easily pushed through the apical foramen.

Table 1 shows location of remnant gutta-percha when the canals were divided into coronal middle and apical thirds. There seems to be an equal distribution of remnant gutta-percha in the two groups in all coronal middle and apical thirds, without any statistically significant differences.

In our study, Table 2 shows that majority of the teeth had several isles of gutta-percha of greater than 2 mm in length (Class VI) followed by 2 to 3 small isles of less than 2 mm in length (Class II). There were no statistically significant differences between the two groups in terms of sizes of the remnant gutta-percha isles. Our results were not in agreement with the study by Hulsmann and Slotz¹⁷ who found there were majority of teeth retreated with chloroform that had no remnant gutta-percha (Class I). Their second highest score was of teeth with one to three small isles of less than 2 mm of remnant gutta-percha (Class II) which is similar to our study.

Limitations of the Study

- Only two solvents were evaluated
- Rotary systems could not be incorporated into the study due to funding limitations.

CONCLUSION

There is no significant difference between the effectiveness of orange oil and chloroform in gutta-percha removal. Thus,

orange oil can be used as an effective alternative to chloroform.

Clinical Importance and Recommendations

With an increase in the number of teeth retained and restored in our population today, it becomes important to research retreatment techniques and safe yet effective solvents.

More studies should be done on other techniques of gutta-percha removal especially techniques using the contemporary rotary instruments.

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