ORIGINAL ARTICLE

Dissolving Efficacy of Different Endodontic Solvents For Gutta Percha With Varying Time Intervals

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ABSTRACT: Endodontic retreatment requires the efficient removal of old gutta percha from the root canal system. **OBJECTIVE:** The aim of this study was to assess the solubility of gutta percha in different endodontic solvents commonly used in dentistry as well as the effect of changing the immersion time from 2 to 5 min.
METHODOLOGY: A total of sixty ISO size 40 gutta percha points were weighed prior to immersion and after immersion in five different solvents at 2 min and 5 min respectively. Distilled water was used as a control solvent. The weight loss obtained was considered a measure of the dissolving efficacy of the corresponding solvent. Mean values for each set of data was obtained. Data was analysed by SPSS version 23 using one way ANOVA and correlations were tested.
RESULTS: The highest dissolution was obtained with chloroform followed by eucalyptus oil, benzene, orange oil and xylene respectively for 2 min. No significant difference was found by increasing the time interval from 2min to 5min.
CONCLUSION: Considering the balance between the biocompatibility and dissolving capacity of each solvent, eucalyptus oil is recommended as the solvent of choice with a 2 min immersion time for safe and effective gutta percha removal.
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INTRODUCTION

In the new prospective Toronto Study, the "healed" rate of endodontic retreatment cases is reported to be 81%. Based on these results, it appears that if a failure is retreated by conventional means, the success rate is very high in teeth without periapical lesions1 Creating a successful result with endodontic retreatment calls for the efficient removal of gutta percha from the root canal system. Various studies have been conducted to find out the most effective way to remove gutta percha from the canals.[1] Conventionally, the removal of gutta percha from the root canal system has been achieved with rotary files, handfiles, ultrasonic tips, Gates Glidden burs and gutta percha solvents. Most of the times, it is a combination of these strategies which results in a successful procedure.

The commonly used gutta percha solvents include chloroform, halothane, benzene, tetrachloroethylene, xylene, eucalyptus oil and refined orange oil.[1] All of these solvents exhibit some degree of toxicity for the periapical tissues and should be used with caution. However, recent studies carried out on chloroform have also raised questions about its potential carcinogenicity.[1]

Given the importance of non-surgical retreatment in endodontics, it is imperative that ways be found by which gutta percha removal is done efficiently and safely. The status of periapical tissue health depends greatly on the complete removal of the obturation from the canals and thereafter re-cleaning till complete asepsis is achieved.[1] In such a scenario, the choice of the gutta percha solvent used and its biocompatibility can greatly influence the treatment outcome.

This study aims to compare the commonly used gutta percha solvents namely chloroform, xylene, benzene, eucalyptus oil and orange oil.[1,2] The solvents are compared both in terms of their dissolving efficiency as well as in the impact of immersion time on their dissolving efficacy. Although many studies have been conducted on the subject, the comparison of all the above mentioned endodontic solvents in one study is uncommon. Keeping in view the

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fact that these solvents are most commonly used for retreatment endodontics in Pakistan, this study aims to compare the results in a controlled in-vitro environment.

METHODOLOGY

An in-vitro experimental study was conducted at the Multidisciplinary Research Laboratory at Bahria University Medical and Dental College from May 2017 to Feb 2018. Ethical approval was obtained from the Ethical Review Committee at Bahria University Medical and Dental College prior to the commencement of the study. Simple random sampling was done and 60 gutta percha cones of ISO size 40 were selected for the trial . 30 gutta percha cones were assigned to the 2min immersion group while the other 30 were assigned to the 5 min immersion group. The solvents used in the study included benzene, chloroform, eucalyptus oil, orange oil and xylene. Distilled water was taken as control. The gutta percha were placed in petri dishes and weighed on a digital weighing scale. The readings were recorded as W1 i.e. the weight of the gutta percha point before immersion in the solvent. Later, six glass beakers were taken; each labelled with the name of the solvent and one with distilled water. A 5ml sample of each solvent and distilled water was then poured into the respective beaker. One gutta percha cone was taken and placed into each solvent. Immediately after placement, timing was started in a stopwatch. Samples were removed from the beaker after a lapse of 2 min. If the gutta percha stuck to the glass beaker during removal, it was dislodged with vibrations on a vortex shaker to prevent clumping. The gutta percha was later placed in a humidifier for drying for a period of 24 hours. After 24 hours the sample was removed from the humidifier and weighed on the same digital scale as before. This weight was recorded as W2 i.e. the weight of the gutta percha after immersion in the designated solvent. The process was repeated for an immersion period of 5 min until all gutta percha cones were used and readings were recorded. The gutta percha points that were distorted or broken during the process were excluded from the final sample. A total of 24 gutta percha points were excluded from the final analysis, bringing the sample size down to 36.

The extent of gutta percha dissolution was taken as a measure of the dissolving efficacy of the solvent and was measured as:

W= W1-W2

Where W was the difference between pre and post immersion weights; W1 was pre-immersion weight and W2 was post immersion weight.

The data thus obtained was recorded in an MS Excel sheet and two data sets were created. One data set provided the readings for 2 minutes immersion. The other data set provided the readings for 5 minute immersion. Means were calculated for both data sets and copied to SPSS version 23 for further analyses. One way ANOVA was applied and correlations were tested. Level of significance was set at 0.05 with a 95% confidence interval.

RESULTS

Immersion Time: 2 min (Table 1, Fig. 1)

The results from the study showed that chloroform exhibited the maximum dissolution followed by eucalyptus oil, benzene, orange oil and xylene in descending order.

Table 1: Weight loss of gutta percha after 2 min immersion in various solvents

Solvents	W1*(mg)	W2**(mg)	W^=W1-W2(mg)	$W_m^{\wedge\wedge}$(mg)
Chloroform	28.6	27.3	1.3	
	28.7	27.5	1.2	1.5
	28.3	26.2	2.1	
Xylene	27.5	27.3	0.2	
	27.6	27.0	0.6	0.4
	27.7	27.3	0.4	
Benzene	28.2	27.6	0.6	
	28.0	27.0	1.0	0.7
	27.5	27.0	0.5	
Orange oil	28.5	27.8	0.7	
	28.8	28.1	0.7	0.7
	28.7	28.1	0.6	
Eucalyptus oil	28.0	27.3	0.7	
	28.0	27.0	1.0	0.9
	27.4	26.3	1.1	
Distilled water	28.1	27.9	0.2	
	27.0	26.6	0.4	0.2
	27.1	27.0	0.1	

W1*= weight of gutta percha before immersion in solvent.
W2**= weight of gutta percha after immersion in solvent.
W^=loss of gutta percha after immersion in solvent.
$W_m^{\wedge\wedge}$= mean weight loss of gutta percha after immersion in solvent.

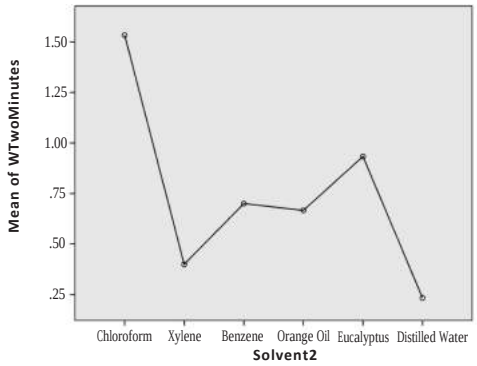

Fig.1: Weight loss of gutta percha after 2 min immersion in solvent. **X-axis** shows the solvents used for 2min immersion, whereas **Y-axis** shows the mean values of weight loss (W_m) obtained after immersion of the gutta percha in the respective solvent for 2 minutes.

The difference in dissolving efficacy between the solvents was significant as p value was found to be 0.01(Table 2)

Table 2: Comparison of dissolving efficacy after 2 minute immersion by using ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.138	5	.628	8.894	.001
Within Groups	.847	12	.071		
Total	3.984	17			

Immersion Time: 5 min (Table 3 , Fig.2)

The results showed that chloroform continued to exhibit the maximum dissolution. However, eucalyptus oil and xylene showed similar results followed by benzene and orange oil in descending order.

Table 3: Weight loss of gutta percha after 5 min immersion in various solvents

Solvents	W1* (mg)	W2** (mg)	W^=W1-W2(mg)	$W_m^{\wedge\wedge}$ (mg)
Chloroform	26.5	25.0	1.5	
	25.5	24.5	1.0	1.2
	26.6	25.6	1.0	
Xylene	26.2	25.8	0.4	
	26.7	26.0	0.7	0.6
	27.1	26.4	0.7	
Benzene	26.2	26.1	0.1	
	27.5	26.8	0.7	0.4
	27.5	27.0	0.5	
Orange oil	27.8	27.7	0.1	
	26.8	26.5	0.3	0.3
	27.6	27.2	0.4	
Eucalyptus oil	27.7	26.7	1.0	
	27.1	26.8	0.3	0.6
	27.1	26.5	0.6	
Distilled water	27.1	27.1	0.0	
	27.7	27.6	0.1	0.1
	27.0	26.9	0.1	

W1*= Weight of gutta percha before immersion in solvent.
W2**= Weight of gutta percha after immersion in solvent.
W^=Loss of gutta percha after immersion in solvent.
$W_m^{\wedge\wedge}$ = Mean weight loss of gutta percha after immersion in solvent.

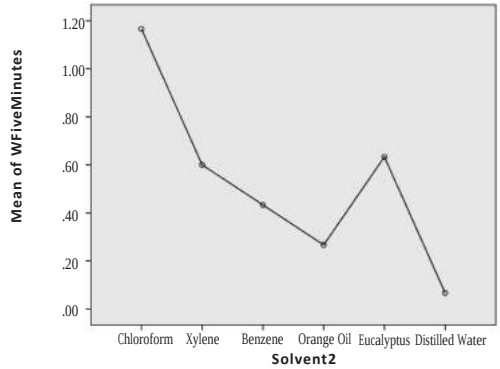

Fig. 2: Weight loss of gutta percha after 5 minute immersion in solvent.
X-axis shows the solvents whereas **Y-axis** shows the mean values of weight (W_m) obtained after immersion of the gutta percha in the respective solvent for 5 minutes.

The difference of dissolving efficacy between the solvents was significant as p-value was found to be 0.02 (Table)

Pearson's correlation showed that the two sets of readings i.e. with 2 min and 5 min were not linearly associated (Table).

There was no significant change or increase in the dissolving efficacy when the time was increased from 2 min to 5min. Rather, a comparison of the means of the two sets of readings shows that xylene is the only solvent in which dissolving efficacy increased with an increase in time from 2 min to 5 min. However, statistically, the difference was not found to be significant.

Table 4: Comparison of Dissolving Efficacy After 5 Minute Immersion Using ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.143	5	.429	7.209	.002
Within Groups	.713	12	.059		
Total	2.856	17			

Table 5: Pearson's correlation values for 2 and 5 minute immersion time.

		W_m Two Minutes	W_m Five Minutes
W Two Minutes	Pearson Correlation	1	.651**
	Sig. (2-tailed)		.003
	N	18	18
W Five Minutes	Pearson Correlation	.651**	1
	Sig. (2-tailed)	.003	
	N	18	18

**. Correlation is significant at the 0.01 level (2-tailed).
W_m stands for the mean weight loss after immersion in solvent.

DISCUSSION

The removal of gutta percha in retreatment cases by mechanical methods alone may lead to canal perforation, canal straightening or alteration of the original canal outline.[2] Therefore, choosing the right gutta percha solvent can be crucial for successful retreatment cases. The ideal gutta percha solvent should not only allow quick and complete removal of all traces of gutta percha from the canal system but also be biocompatible to avoid any periapical irritation or inflammation.[3,4,5] When the canal system is efficiently cleaned and disinfected and periapical healing is achieved, only then can retreatment have a good prognosis.[6,7] Hence the choice of a good solvent depends on the balance between the clinical safety in usage versus its capacity for dissolution.[8,9] The coronal gutta percha can be removed with either Gates Glidden burs, a heated plugger or a heating device like Heat n Touch or System B.[10] This creates a small reservoir on the

canal orifice. A drop or two of solvent can then be placed on the orifice, and the canal is gradually entered with a no. 10, 15 or 20 stainless steel K file, watch winding continuously to carry the solvent deeper into the system.[11] Once the apical stop is negotiated, the gutta percha is removed by using progressively larger K files or by H-files. In most cases, the combined use of different techniques can provide better results than relying on one method alone.

In clinical practice, chloroform is the most effective and widely used endodontic solvent for gutta percha removal.[12] It is rapid in action and easily evaporates which makes it a useful chairside material. On the contrary, chloroform tends to be messy as it dissolves rather than softens[13] and because of its quick evaporation, a greater quantity of material is required. Above all, its potential carcinogenicity raises concerns about its use in the future.[1,3,4]

Some researchers have mentioned xylene as the best substitute for chloroform as an endodontic solvent[12] whereas others have stated that it has the same efficacy as orange oil.[13] Xylene is an aromatic organic solvent and allows better control of gutta percha during removal as it slowly softens rather than dissolve gutta percha.[14,15] This can be accomplished by placing a cotton pellet dipped in the material inside the pulp chamber and removing the gutta percha on the following visit. This holds especially true for aged gutta percha as it tends to get very hard and difficult to remove.[16] However, xylene is not without its adverse effects as there have been reports of its potential neurotoxicity and damage to the periapical tissues, warranting its use with caution.[17]

Benzene was also evaluated as a solvent and produced similar results to xylene. However, benzene was more effective in dissolving gutta percha in the 2 min time interval whereas xylene showed better performance in the 5-min time interval.

Refined orange oil or D-Limolene is extracted from the peel of sweet orange and is found widely in citrus and many other plant species. It is an essential oil and is favored for its low toxicity to periapical tissues.[18] In this study, orange oil proved to have the least dissolving efficacy when compared with the other solvents. Other studies have provided mixed results with some citing orange oil to be comparable with xylene in its dissolving capacity.[18]

The use of essential oils in endodontics is growing because of their proven biocompatibility, low toxicity and non-carcinogenicity. Eucalyptus oil is another essential oil solvent which has shown its capacity for endodontic dissolution. Eucalyptus oil is the distilled oil obtained from the leaves of Eucalyptus globulus. Its major constituent is 1, 8 cineole, which exhibits antibacterial and anti-inflammatory properties.[18] In our study, eucalyptus oil showed excellent results both in the 2 min as well as 5 min time interval. However, in the 5-min category, eucalyptus oil showed the same reading as xylene. From the results of this study, we can safely assume that eucalyptus oil can be used as the best alternative to chloroform for gutta percha removal. All the solvents used showed superior dissolving efficacy in the 2 min time interval except for xylene. Statistically, the difference between readings obtained after 2 min and 5 min was not found to be significant. This means that the maximum dissolution is achieved within the first 2 min of immersion and increasing the time interval to 5 min has no positive correlation with dissolving efficacy.[18,19,20]

However, the sample size of this study was limited so a larger number of gutta percha used could have affected the results. Moreover some studies state that the brand of gutta percha used can produce differences in the effects of the solvents.[21] Moreover, clinical factors like root configuration, amount and type of sealer used and the age of the gutta percha can also influence the outcome.[22,23,24]

CONCLUSION

In the light of these results, it can be concluded that chloroform has the highest dissolving efficacy amongst the tested endodontic solvents.[25,26] However, given the toxicity and carcinogenic effects associated with chloroform, it cannot be recommended for standard use.[27] Eucalyptus oil is a good alternative and promotes softening of gutta percha for easy removal after 2 min of immersion. Changing the immersion time from 2 min to 5 min does not produce any significant change in the dissolution of gutta percha.

CONFLICT OF INTEREST

None declared.

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