

# Efficacy of Orange Oil, Lemon Oil and Xylene as Solvents in Removing Gutta Percha from Curved Root Canals: An In-vitro Study

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## ABSTRACT

**Introduction:** Root Canal Treatment (RCT) is the most common and effective treatment for saving natural tooth. Despite of modern technology and progress in the materials, failures in endodontic treatment still remains. Microbial infection majorly bacteria in the root canal is the prime cause of reinfection in root canal treatment. Endodontic instruments, solvents, lasers are the different techniques that can be used for removing gutta percha from the root canal.

**Aim:** To compare the efficacy of orange oil, lemon oil, and xylene as solvents in removing gutta percha from curved root canals.

**Materials and Methods:** This in-vitro study conducted in Sharad Pawar Dental College and Hospital, Sawangi Meghe, Wardha, Maharashtra, India, for three months and 24 freshly extracted teeth including incisors, premolars and molars having curved root

will be taken. Then, RCT would be performed in all the extracted teeth by using cold lateral compression obturation method. Then all teeth would be divided in three groups (n=8). After one month, the Gutta Percha (GP) would removed by ProTaper Universal system. First group will use orange oil as solvent, second group will use lemon oil as solvent and the third group will use xylene as a solvent. The micro-Computed Tomography (CT) images prior to the application of solvent and after application of solvent will be taken and would be evaluated to check the percentage of filling material remaining.

**Results:** The expected outcome is orange oil and lemon oil to act as a better root canal solvent, as compared to xylene.

**Conclusion:** The determination and comparison of the efficacy of orange oil, lemon oil and xylene as GP solvents from the present planned study will help the clinicians during re-RCT treatment.

**Keywords:** Endodontic retreatment, Micro-computed tomography, Re-infection

## INTRODUCTION

Root Canal Treatment (RCT) is the foremost treatment for preserving our natural tooth. In spite of new technology and advancement in the materials, failures in endodontic treatment persist [1-3]. This is mainly identified radiographically, where there are changes in periapical region or there may be symptoms of pain and swelling indicating need for endodontic retreatment [4,5]. The primary reason for lack of success in RCT is the presence of microbial infection mainly bacteria in the root canal [6]. Therefore, non surgical treatment is usually practiced. An endodontic retreatment removes obturating material from the canal and facilitates biomechanical preparation and obturation of the canal [7,8]. There are many obturating materials like dental amalgam, gold foil, lead, copper, oxy-chloride of zinc, paraffin, that are used but gutta percha is primarily used as it has low toxicity [9].

Many techniques can be used for taking out GP from the root canal. The use of hand instruments like Hedstrom file and Gates Glidden drill is practiced. Rotary instrument like Nickel-Titanium (NiTi) rotary instrument can also be used [10]. Generally, ultrasound can only be used on hard compounds such as Glass Ionomer Cement (GIC) or as final debridement in endodontic retreatment. Laser can also be used to remove gutta percha like Nd:YAP (Neodymium-doped Yttrium Aluminum Garnet), which is more effective in dry root canals [11]. Furthermore, when solvent is used, it facilitates in taking out filling material. Drawing out of filling material mechanically will only reduce the bulk but the solvent will soften the GP and remove the remnants of it. Various solvents can be used to take out the filling material like- chloroform, tetrachloroethylene, orange oil, eucalyptol, xylol, xylene, tetrahydrofuran and methylene chloride [12],[13]. As per the United States Food and Drug Administration, though chloroform is considered the most effective solvent but because of its carcinogenicity, it is not commonly used. Also, though xylene

is not considered a carcinogen, it harms the living tissue. Xylene can cause Central Nervous System (CNS) depression, pathologies related to heart and liver, blood disorders, decreased concentration, insomnia and tremors [14].

The present study differs from other studies as xylene is harmful to the living tissue and has various side effects on humans, so the present study aims to find a better alternative against xylene [14]. Also, the present study conducted in-vitro, uses freshly extracted teeth with curved root canals. In root canals that are curved, removing filling material and further instrumentation can be challenging than straight root canals. Also, very less studies have been conducted on curved root canals [15]. The gutta percha solvents used in the present study have not been compared together in any other study. The aim of the present study would be to evaluate the efficacy of orange oil, lemon oil and xylene as GP solvents in retreatment in endodontics.

## MATERIALS AND METHODS

This in-vitro study would be conducted in Sharad Pawar Dental College and Hospital, Sawangi Meghe, Wardha, Maharashtra, India. The approximated time for the study is three months. The ethical approval was taken from Institutional Ethical Committee (DMIMS (DU)/IEC/2022/976).

**Inclusion criteria:** Teeth with curved root canals and freshly extracted teeth were included in the study.

**Exclusion criteria:** Fractured teeth, resorbed root, teeth with straight root canals and teeth with pulp stone were excluded from the study.

**Sample size calculation:** Formula used:

$$n=2 (Z1-a + Z1-\beta) 2 p(1-p)/d$$

d=0.01, Level of significance a=0.05, Power 1-β=0.80, Z alpha value=at 90% 1.645, at 99% 2.576, at 95% 1.96, at 80%, 1.282 G power analysis

Input: Tail(s)=One, Effect size  $|\cdot|=0.1$

a err prob=0.05, Power (1- $\beta$  err prob)=0.95, Output: Non centrality parameter  $d=3.39$ , Critical  $t=1.6589$

Df=31, Actual power=0.9503

Where  $n$ =total sample size,  $d$ =non centrality parameter,  $Z$ =critical value,  $p$ =sample proportion,  $\alpha$ =type 1 error,  $\beta$ =type 2 error

The sample size determined was 24 considering the dropouts, sample size has been estimated 8 samples in every group.

A total of 24 freshly extracted teeth with curved root canals would be taken with eight teeth in each group and presented as follows:

Group A: 8 teeth- orange oil

Group B: 8 teeth- lemon oil

Group C: 8 teeth- xylene

### Study Procedure

Recently extracted 24 teeth will be included in the planned in-vitro research and access opening would be done using endo-access bur and Z bur and the opening would be enlarged by Gates Glidden drill. Teeth will be prepared using Protaper universal system. While biomechanical preparation of the canal with electrically driven instruments, the canals would be cleaned using 5.2% of Sodium Hypochlorite (NaOCl) solution, 17% Ethylenediamine Tetraacetic acid (EDTA) and the final irrigation with the help of saline would be done. Paper points will be used to dry the canal and the teeth would be obturated using cold lateral compression technique with GP. As the material sets with time, therefore after one month, gutta percha will be retrieved from the curved canal using Protaper Universal system.

**Group A:** ProTaper Universal system would be used to take out GP from the curved canal. For two minutes, orange oil commercially available as DPI GP solvent, will be introduced into the curved root canal to soften GP after instrumentation.

**Group B:** Same as group A, but instead of orange oil, lemon oil commercially available as Pyrax RC Clean GP Solvent will be used.

**Group C:** Same as group A, but instead of orange oil, xylene will be used.

Then the micro-CT images prior to the application of solvent and after application of solvent would be taken and will be evaluated to check the percentage of remaining filling material.

### Micro-Computed Tomography (CT)

Micro-CT is a three dimensional imaging technique which can be used to visualise hard tissues of the oral cavity like alveolar bone, dentition; soft tissues can also be visualised that have infiltrative growth such as in cases of carcinoma. Along with these ceramics, crowns, obturating material can also be seen in micro-CT [16]. In the present study, micro-CT images prior to the application of solvent and after application of solvents was checked to evaluate the percentage of remaining GP in the curved root canal. Under voltage of 100 kV and current of 100  $\mu$ A with aluminium and copper filters and at 360°, all samples would be scanned with a rotation step of 0.4°. Each tooth sample will be reconstructed three dimensionally and the data sets will be analysed. Gutta percha would be measured in  $\text{mm}^3$  following which, the mean value of every sample would be calculated.

### STATISTICAL ANALYSIS

The intergroup comparison will be done by one way Analysis of Variance (ANOVA) test and descriptive statistics applied for mean and standard deviation of the variables. The  $p$ -value  $<0.05$  level was considered as level of significance. Specimens would be scanned with Skyscan 1172 (Bruker\_micro-CT 1172, Kontich, Belgium).

### RESULTS

Due to the hazardous effects of xylene, the efficacy of lemon oil and orange oil as GP solvents are expected to be better during re-RCT procedure for the clinicians.

### DISCUSSION

Failure of the re-RCT occurs, due to remaining GP in the canal hence, its complete removal is an important aspect in the procedure. Number of studies reveal that the major aetiology of RCT failure is due to residual gutta percha in the canal [17-19]. Widely used root canal solvents are xylene, chloroform and turpentine oil. Among these solvents, xylene is the most commonly used solvent, but it has hazardous health effects like ailments related to heart and liver, depression, skin erythema and Central Nervous System depression. Also, xylene is highly toxic to living tissues [20,21]. Thus, there arise a need to find a better root canal solvent.

In the present study, the authors would attempt to find a better solvent which is more effective and more biocompatible as compared to the solvents that are in use till date. In a study done by Pecora JD both orange oil and xylol acts in a similar manner on gutta percha, but orange oil is less hazardous to living tissue [22]. In order to measure the effectiveness of root canal solvents, a variety of techniques have been used. The GP residuals have been measured using radiographs or photographs are also used to measure longitudinally split roots [23-26]. A study used root transparency to check for the GP residue in the root canal [27]. Recently, micro-CT analysis has become increasingly popular for assessing the efficacy of retreatment procedures [15]. Using micro-CT as a diagnostic tool is advantageous because it offers quantitative three-dimensional assessment of residual gutta percha, filling materials, dentin and sealant separately [28].

Saglam BC et al., in their study used micro-computed tomography to evaluate two root canal solvents, chloroform and endosolv, used in the curved root canal to remove filling material [15]. Likewise in the planned research study, micro-CT and curved canal will be used. In the study done by Saglam BC et al, [15] the retreatment procedure was conducted to remove gutta percha remnants with ProTaper Universal System and self-adjusting files were also used in the similar manner as the present study also plan to use the same armamentarium. In a study conducted, it was confirmed that orange oil is good solvent which is non toxic and has good biocompatibility [29]. On the other hand, xylene removed the covalent bonds of carbon but it also induces a toxic reaction by an intermediate metabolic product, methyl benzaldehyde [14]. Thus, orange oil is considered more beneficial as compared to xylene as a GP solvent.

In a study, done by Jantarat J et al., dissolving capacity of different essential oils containing different D-limonene concentrations was evaluated. Their study included grapefruit oil, tangerine oil, lime oil, and lemon oil. The results stated that, the oil that contained a greater percentage of D-limonene had a significantly higher dissolving effect on the gutta-percha. The author evaluated the dissolving ability of many essential oils that contain different D-limonene concentrations. Their study used grapefruit oil (90% D-limonene), tangerine oil (90% D-limonene), lime oil (60% D-limonene), and lemon oil (60% D-limonene). The results demonstrated that, after a five minutes of contact time, the oil that contained a higher percentage of D-limonene had a significantly higher dissolving effect on the GP [30].

Similarly in present study would use solvents containing D-limonene (orange oil, lemon oil). A clear colourless liquid with a pleasant lemon-like odor is D-limonene which is soluble in ethanol. On oxidation, it forms a film in air, and has oxidation behavior similar to that of rubber or drying oils [31]. Limonene is the active ingredient in citrus fruit oil and is used as a less hazardous substitute for xylene in histopathology and microscopy. The 3-cyclohexen-1-ol, 4-methyl-1-(1-methylethyl) which is the most abundant constituent

and a derivative of limonene, is responsible for antimicrobial activity [32]. Limonene reagents are advocated as potential substitute as dissolvent over xylene with least biological hazards [33].

## CONCLUSION(S)

The present planned protocol would compare and determine the most effective and efficient root canal solvent amongst orange oil, lemon oil and xylene to help the clinicians in re-RCT treatments.

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