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# Evaluation of the Dissolving Efficacy of Four Organic Solvents on Gutta-Percha: An in Vitro Study.

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***Abstract***
***Aim****: The aim of this study was to evaluate the dissolving efficacy of four organic solvents on gutta-percha.*
***Materials and methods****: Seventy five samples of gutta-percha were prepared using a standardized stainless steel mould and divided into five groups for immersion in the different solvents i.e. Chloroform, Turpentine oil, Eucalyptol, GP solvent (safe plus) and in distilled water (control group) for 2, 5 and 10 minutes. 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. Data was statistically analyzed by Analysis of Variance (ANOVA) and multiple comparisons with Scheffes test (p < 0.05).*
***Result****: The best solvent effect was obtained with eucalyptus oil, followed by GP solvent while chloroform and turpentine oil showed similar solvent effects.Distilled water did not promote alterations in the gutta-percha.*

## I. Introduction

Endodontic treatment success is directly related to many factors associated as links in a chain so that one is broken; the probability of treatment failure markedly increases[1]. Among these factors, is the accurate diagnosis, maintenance of the aseptic chain, knowledge of tooth morphology, correct chemical-mechanical preparation and tridimensional filling of the root canal system. Possible faults in any of these steps will lead to endodontic treatment failure[2].Non surgical endodontic retreatment is an attempt to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated canal system because of coronal or apical leakage. It requires regaining access to the entire root canal system through removal of defective root canal filling, further cleaning and shaping and reobturation[3].

Gutta percha is the most popular core material used for obturation[4]. Removal of gutta percha can be done with several techniques[5]. Knowing the risk of the use of purely mechanicalmeans to remove gutta-percha, such as perforation,fracture or alteration of the original root form, severaltechniques have been proposed seeking efficiency, speed and practicality in gutta-percha removal. These includethe use of heated instruments, of microscopes, or ofmanual instruments either by themselves or combinedwith sonic apparatuses or Gates-Glidden drills in thecervical third. The use of solvents is, however, necessary for alltechniques for removal of gutta-percha[6,7,8].According to Stabhouz and Friedman, the use of solvents is essential for filling material removal within dentinal tubules and ramifications, therefore making easy the biomechanical preparation and the penetration of the irrigant solutions and intracanal medications[9].

Among the chemical solvents, xylene and chloroform have been some of the options more commonly employed. But the U.S Food and Drug Administration prohibit chloroform because of its potential carcinogenicity. Despite of the easy gutta-percha removal obtained with the chemical solvents, these substances may show different degrees of dissolution and removal of the filling material from root canal and because of their toxic potential they may provoke damage to the patient. Trying to balance the effectiveness and toxicity of the solvent, many authors have employed eucalyptus and pine tree essential oils because gutta percha is soluble in these oils in the same way like in xylol and chloroform without presenting any deleterious effects[10].

The purpose of this study was to comparatively evaluate the dissolution efficiency of different gutta percha solvents at three time intervals.

## II. Material And Method

In this study standardized gutta-percha (Sure endo-Dentsply) was used as a test material. Solvents tested were Chloroform, Turpentine oil, Eucalyptus oil, and GP solvent (Safeplus: D-limonene, oil of citronella, oil of orange). Distilled water was used as a control group. Standardized stainless steel moulds with 8 mm in diameter and 5 mm in height were used for sample preparation (Figure 1).Master cones of gutta-percha were heated and condensed into sample moulds and left to set at room temperature for 48 hours (Figure 2). Excess material was then trimmed to the surface level of the mould with a scalpel.75 discs of gutta-percha were prepared and divided into 5 groups of 15 each, for immersion in chloroform, turpentine oil, eucalyptus oil, GP solvent and distilled water.These were further divided into 3 equal subgroups (n = 5) for 2, 5 and 10 minutes. Samples were weighed in a digital analytical scale in grams and recorded to four decimal places in triplicate

(Figure 3).Gutta-percha discs were immersed in 20 ml of respective solvent at room temperature in an amber glass bottle with a screw cap so that both surfaces of each sample were freely accessible to the solvent.

Samples were removed after the specified immersion periods and washed in 100 ml of distilled water and allowed to dry for 24 hours at 37 degree C. The extent of gutta-percha dissolution from the specimen was calculated from the difference between the original weight of gutta-percha and its final weight using the following equation:

$$M=M_2- M_1$$

Where,

$M_2$ = Post immersion weight

$M_1$ = Pre immersion weight

Means and standard deviations of percentage loss of weight were calculated at each time interval for each group of specimens. The difference in dissolution of gutta-percha along the different times tested was calculated by Two-Way ANOVA. Multiple comparisons with Scheffé's test were further performed to compare the effect of the different solvents in different times with the value of statistical significance set at 0.05[11].

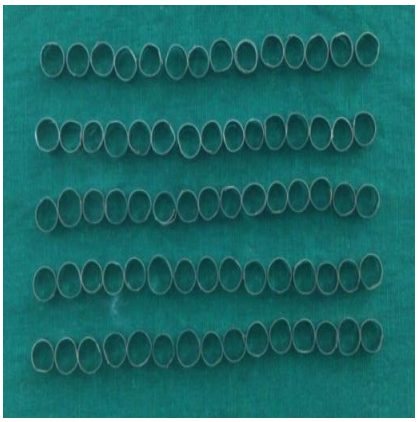

Figure 1

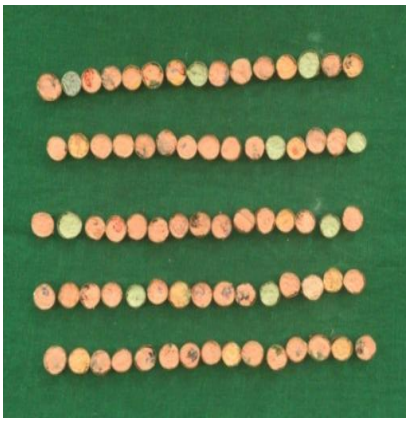

Figure 2


**Figure 3**

## III. Results

Dissolving efficacy of four organic solvents on gutta-percha was evaluated at time intervals of 2, 5, and 10 minutes. Means and Standard Deviation of gutta-percha solubility in solvents during immersion times is presented in the table. Solubility is expressed as weight loss in grams.

| | Chloroform | Turpentine | Eucalyptus | GP Solvent | Water |
|---|---|---|---|---|---|
| 2 min | 0.53±0.05 | 0.61±0.03 | 0.65±0.05 | 0.57±0.10 | 0.01±0.05 |
| 5 min | 0.65±0.08 | 0.52±0.03 | 0.57±0.05 | 0.56±0.05 | 0.03±0.04 |
| 10 min | 0.62±0.03 | 0.60±0.08 | 0.53±0.02 | 0.55±0.07 | 0.06±0.02 |

For the first batch of samples with immersion time 2 minutes, all solvents presented similar effects with no statistic difference except the control group.

For 5 and 10-minutes immersion time, eucalyptus oil displayed a markedly superior ability in dissolving gutta-percha in comparison to the other solvents ($p < 0.05$). Chloroform, turpentine and GP solvent groups did not show statistically significant differences at 5 and 10 minutes interval ($p > 0.05$). The best solvent effect was obtained with eucalyptus oil, followed by GP solvent while chloroform and turpentine oil showed similar solvent effects. In the distilled water control group, no gutta-percha discs were dissolved and distilled water did not promote alterations in the gutta-percha.

## IV. Discussion

The basic aim of nonsurgical endodontic retreatment is to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated root canal system because of coronal or apical leakage. The procedure involves regaining access to the entire root canal system through removal of the original root canal filling, further cleaning and reobturation[3].Removing as much sealer and filling material as possible from inadequately prepared and filled root canal is critical to uncover remnants of necrotic tissue or bacteria that may be responsible for periapical inflammation or failure[12]. Gutta-percha can be removed without great difficultywith the use of an organic solvent or heated instrument.Our results showed that eucalyptol is themost effective for gutta-percha dissolution compared to the other tested solvents. Chloroform, turpentine and SafePlus GP solvent showed similar solvent effects, whiledistilled water showed no dissolution ability.Chemical methods for gutta-percha removal ordecontaminationhave been used for a long time.Nevertheless, substances that are the most effectivesolvents have the most potential toxicity. Severalstudies report that even substances which are usedfar from the periapex, such as in the pulp chamber,can reach the periapical tissues[13]. Chloroform is classified among thesolvents with major capacity of dissolution of guttaperchaand also as those which present the most undesirableeffects to the periapical tissues as well asbeing considered potentially carcinogenic and neurotoxic[14].

The use of essential oils in endodontics is growingbecause of their proved safety, biocompatibility andnon-carcinogenicity[15]. The results of this study indicatethat both eucalyptol (the main constituent of eucalyptusoil) and orange oil(the main constituent of SafePlus GP solvent) are suitableas solvents, for dissolving or softening gutta-percha.Essential oil extracted from the peel of sweet orange,*Citrus aurantium,* is easy to obtain and suitablefor rapid opening of the root canal. Orange oil is an excellentalternative solvent as compared to potentially toxicsolvents[16]. Eucalyptus oil exhibits antibacterial effects and anti-inflammatoryproperties and its potential of dissolution ofgutta-percha is also very good[17]. Furthermore, after emptying the root canals,this solvent is easily removed by irrigation. The eucalyptus oil and the GP solvent showed more effectiveness at the time interval of 10 minutes where as chloroform and turpentine showed no statistical significance at 10 minutes. These data are according to previous studies of Della Nina et al, where they analyzed the solvent dissolving ability of several solvents through weight loss[18]. Our results confirm the observation made by other authors where they describe that essentials oil presents the same action as chloroform. In addition, Spanó et al, mentioned the solvent dissolving ability of essentials oils, and they concluded that they can substitute the toxic solvents[19].In the present study, the effect of eucalyptus oil or eucalyptol solvent was statistically similar to the study by Hunter *et al. in* 1991[20] but differing from other investigations that observed significantly less dissolution efficiency.

In this present study, all solvents exhibited the greatest percentage of dissolution at the first minute. It is important to emphasize that gutta-percha points are composed by gutta-percha itself, zinc oxide, waxes, resins and barium sulfate, but the solvents only act on gutta-percha. Accordingly, it seems that this greatest percentage of dissolution occurred at the first minute because at the remaining minutes there would be a smaller amount of gutta-percha within the point so that there was a smaller area of action for the solvent.

Considering the existence of similarity in solventcapacity between essential oils and the otherorganic solvents investigated, we could clinicallyuse eucalyptol and orange oil for a longer time. Theuncontrollable miscibility and penetration depth ofsolutions like chloroform promote an uncontrolledfield reaching the apical region and causinga chemical pericementitis.

With an increase in the number of teeth retained and restored in our population today, the choice of an ideal solvent for endodontic retreatmentrequires the establishment of a balancebetween the level of clinical safety, the level of toxicity and aggression to the tissues and the chemicalcapacity of dissolution.Considering the toxic and carcinogenic effectsof some solvents, this study shows that substanceswhich fulfill the requirements of speedy action, harmlessnessto the tissues adjacent to the tooth, a pleasantsmell and non-toxicity to the professional, the patientand the environment such as essential oils should beindicated for endodontic retreatment.

## V. Conclusion

Within the limitations of this *in vitro* study, wewere able to conclude that:

1. Eucalyptus oil presented a superior solvent effect.

2. Chloroform, turpentine and GP solvent presented similar solvent effects.
3.We should limit the clinical use of solvents that present toxic and carcinogenic effects.

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