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Comparative evaluation of the effectiveness of various solvents on dissolving efficacy of gutta percha- An in vitro- study

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ABSTRACT

This study's objective was to compare how well xylene, chloroform, turpentine oil, halothane, and orange oil dissolved materials at three different immersion time intervals.
For the investigation. An ISO no. 40 cone and gutta-percha cones with a 0.06 taper were gathered. In each of the tested solvents, five batches of samples were made and submerged for 6, 12, and 18 minutes. To ascertain the process of gutta-percha dissolution in the solvents, the weight before immersion and the weight after immersion in the solvents were measured on a digital analytical scale. Analysis of Variance (ANOVA) and multiple comparisons with Scheffe's test (p 0.05) were used to statistically analyse the data. With xylene, the best solvency capacity was attained. Halothane, orange oil, and chloroform all had comparable dissolving abilities.

1. Introduction

Ineffective treatment or reinfection of an obturated root canal system due to coronal or apical leaking may result in non-surgical endodontic retreatment, which is an effort to restore healthy periapical tissues. It necessitates removing the flawed root canal filling in order to regain access to the full root canal system.[1,2] The success percentage of endodontically treated teeth is between 86% and 95%, and retreatment is necessary for root canal-treated teeth that fail. Because it is the least irritating, least poisonous, and easiest to remove filler material for root canal obturation, gutta-percha is most usually employed. Gutta Percha Cones, a type of vegetable resin that gives the product its name, are softerened by chemical solvents. Mechanical, thermal, chemical, or even a combination of these techniques, as well as specialised equipment like ultrasound devices, can be used to remove gutta percha.[3–6]

When performing a retreatment, a chemical class of substances known as organic solvents is used to lessen the resistance of the root canal filling materials, making it easier to remove them without harming the tooth. 7 Chloroform, xylene, halothane, eucalyptol, turpentine, and orange oil are some of the most popular organic solvents used in endodontics.[4–8] Additionally soluble to essential oils is gutta-percha. Some of them, including eucalyptus (eucalyptol) and pine tree (turpentine), have been deemed harmless.[9] All solvents are known to be toxic to the periapical tissues and should be used with caution.[9] During nonsurgical endodontic retreatment, refined orange oil, tetrachloroethylene, and xylene are utilised in clinical practise to soften the gutta percha.

Halothane hasn't been used in any experiments as a gutta percha solvent.

Therefore, the goal of this study was to compare and contrast the dissolution rates of several gutta-percha

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solvents at three distinct time points in order to determine which was the most effective for removing the filling material from root canals during endodontic retreatment.

2. Materials and Methods

For the study, samples of 340 ISO no 40 cones (0.06 taper gutta percha (dentsply)) were collected.

For five experimental groups totaling 66 gutta percha cones each, xylene, chloroform, turpentine oil, halothane, and orange oil were used as the solvents. To further examine the possibility of these solvents for clinical usage in dissolving gutta percha, each group was further separated into three subgroups (n=22) for immersion time intervals of 6, 10, and 18 min at room temperature. Before submerging in the solvent, each sample was first weighed on a computerised analytical scale.

To create the solvent samples, 20 ml of each solvent was placed in a glass vial. Timing was started using a stopwatch as soon as the gutta percha cone was submerged in the solvent. Following the predetermined immersion time, samples were taken out of the glass vial, rinsed in 100 ml of distilled water, and then dried for 24 hours at 37°C in a humidifier. After being immersed in the particular solvent, the samples were once more weighed on a digital analytical scale.

The amount of gutta percha removed from the specimen was determined using the following equation utilising the difference between gutta percha's initial weight and its final weight:

$$M = M2 - M1$$

Where:

M2=post-immersion weight.

M1=pre-immersion weight.

For each time interval, the means and standard deviations of the % weight loss for each set of specimens were computed. The data were put through paired 't' tests, independent 't' tests, one-way ANOVA tests, and multiple comparisons with Scheffe's tests.

3. Results

The weight loss of gutta percha in various solvents as a function of time (Figure 1) revealed that, with the exception of the turpentine and orange oil group, there was no significant difference in the amount of material dissolved at 6, 12, and 18 minute immersion time intervals (P>0.05).

The best dissolving capacity for gutta percha was shown by xylene at 6, 12, and 18 minutes, while turpentine had the lowest capacity. Chloroform and xylene did not exhibit any statistically significant differences at 6 minutes. Orange oil, xylene, chloroform, and halothane did not exhibit any statistically significant differences at 12 or 18 minutes, respectively.

4. Discussion

The complete removal of filling materials from the root canal system is necessary for non-surgical endodontic retreatment to be successful because the presence of filling material remnants in a root canal could reveal bacteria or necrotic tissue that could be the cause of periapical inflammation or failure.[10–12] Several methods can be used to remove gutta percha. Heat carriers like Touch N. Heat or System B can be used to remove the coronal section of the gutta-percha, and Gates-Glidden bursts are also quite successful at doing so.[13]

Gutta-percha has previously been softened and dissolved using solvents. It has been predicted that the use of organic solvents will lessen the resistance of materials that obturate the canal, making it easier to retrieve them when used in conjunction with instruments. However, because very strong solvents can soften the enamel and dentin and can promote canal transportation and chemical pericementitis if they penetrate beyond the apex, clinicians should exercise extreme caution when using removal techniques and materials to dismantle the previous treatment Solvents have been used in the past to soften and dissolve gutta-percha. The use of organic solvents is expected to reduce the resistance of materials that obturate the canal, making it simpler to collect them when used in conjunction with tools. However, doctors should take extreme caution when employing removal procedures and materials to dismantle the prior treatment since particularly strong solvents can weaken the enamel and dentin and can induce canal transportation and chemical pericementitis if they penetrate beyond the apex.

In addition to having a significant ability to dissolve guttapercha, xylene and chloroform are also thought to have the worst effects on periapical tissues and have the potential to be neurotoxic and carcinogenic.[14,15] Numerous organic compounds, including gutta percha (an alkadien; a hydrocarbon), polymers (resilons; a polycaprolactone), resins, and sealants, are frequently thought of as being effectively soluble in xylene.[16,17] This might be as a result of how it affects the covalent connections that connect carbon atoms.

For all of the investigated brands of gutta percha, Tamse et al. discovered that chloroform was the best solvent.[8] The most potent and widely utilised of the solvents, it works swiftly. It is a great material for chair sides due to its quick evaporation.[8] It has, however, been noted as a possible carcinogen.[18] Clinicians and academics are now more interested than ever in developing substitute solvents due to worries about chloroform's carcinogenicity.[18] Chloroform usually leaves residues on the walls of the pulp chamber and is dirty and inconvenient since it dissolves the gutta percha rather than softening it.

Since it evaporates quickly, it is necessary to keep adding solvent as it does so.

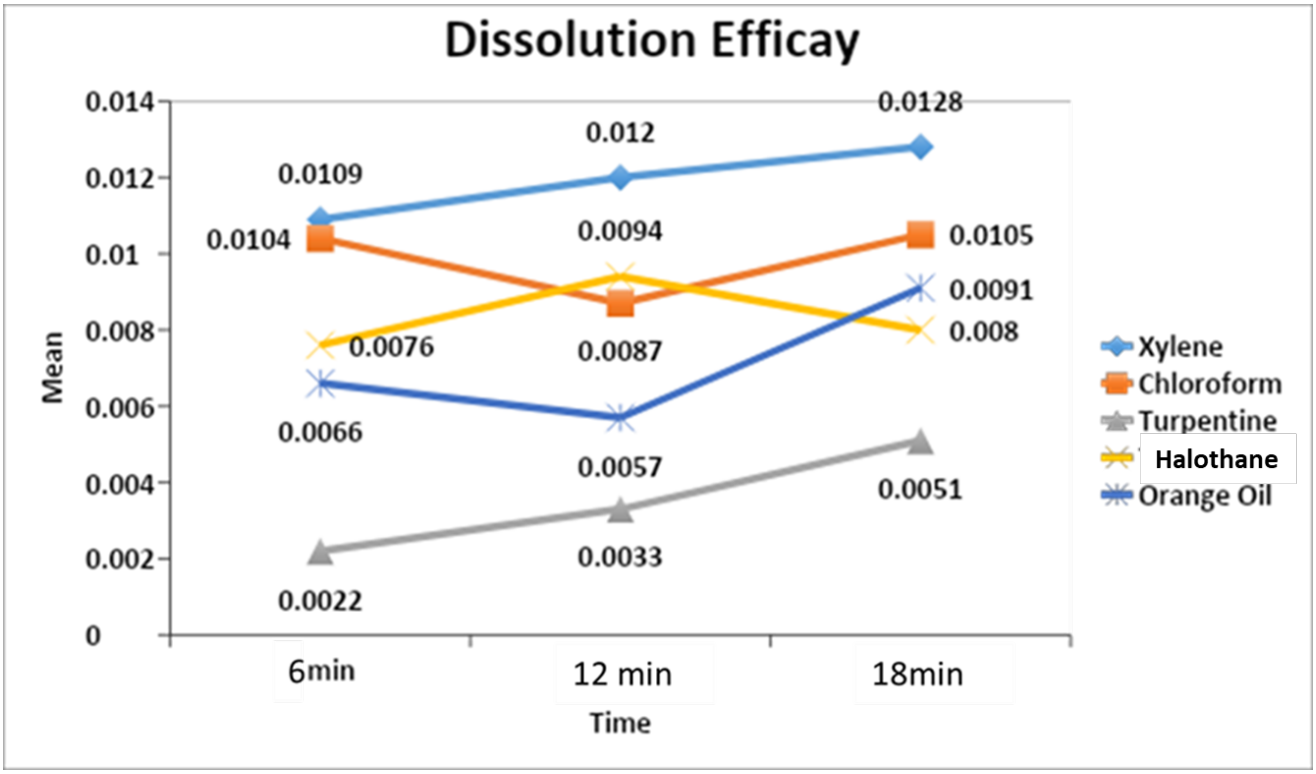

Fig. 1: Time-dependent solubility effect of solvents on gutta-percha. Solubility is expressed as weight loss of gutta percha in grams.

Table 1: Mean and standard deviations of solvency of different solvents at different time intervals.

Time	Group	N	Mean	Std. Deviation
	Xylene	22	0.0109	0.0050
	Chloroform	22	0.0104	0.0034
6 min	**Turpentine**	22	0.0022	0.0011
	Halothane	22	0.0076	0.0039
	Orange Oil	22	0.0066	0.0028
	Xylene	22	0.0120	0.0016
	Chloroform	22	0.0087	0.0044
12 min	**Turpentine**	22	0.0033	0.0033
	Halothane	22	0.0094	0.0043
	Orange Oil	22	0.0057	0.0040
	Xylene	22	0.0128	0.0057
	Chloroform	22	0.0105	0.0057
18min	**Turpentine**	22	0.0051	0.0036
	Halothane	22	0.0080	0.0034
	Orange Oil	22	0.0091	0.0042

As opposed to liquefied gutta percha, which is more difficult to regulate and remove, xylene dissolves gutta percha more gradually. Instead of dissolving gutta percha, softening it and mechanically removing it may prove to be a more effective and physiologically secure method. By placing a cotton pellet that has been wet with a solvent in the chamber and removing the root canal filling the following appointment, this can be achieved.

Because of their safety, biocompatibility, and lack of carcinogenicity, essential oils are increasingly being used in endodontic procedures. Citrus aurantium essential oil is readily available and suitable for opening the root canal quickly, particularly in root fillings made of zinc-oxide cement that are either associated with or not filled with gutta-percha cones. D-limonene, or refined orange oil, is a primary component of many essential oils and is extensively distributed in citrus and many other plant

species. It is widely employed in insect repellents, as a chemical intermediary, and as a component of flavourings and scents.[19]

The weight of gutta percha dissolved was taken into consideration in this investigation when using ISO no. 40 (0.06 taper) gutta percha to test for dissolving in the appropriate solvents. Tamse et al.'s evaluation standards for the amount of material dissolved.[8] The best dissolving capacity was shown in our investigation by xylene. Xylene demonstrated the optimum dissolving efficacy for gutta-percha at 6, 12, and 18 minute immersion time intervals. However, same solvency was also seen for orange oil, halothane, and chloroform.

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Thymus vulgaris, a perennial herb, is the source of halothane. This herb, which belongs to the mint family, is used in aromatherapy, cooking, mouthwash, and potpourri. Halothane has relaxing qualities in addition to being antiseptic, antibacterial, antispasmodic, and hypertensive.

Since the dawn of time, people have utilised halothane as a medicine since it is one of the strongest antioxidants ever discovered. Alpha-thujone, alpha-pinene, camphene, beta-pinene, para-cymene, alpha-terpinene, linalool, borneol, beta-caryophyllene, thymol, and carvacrol are normally the main components of thyme essential oil. Thymol can range from 20% to 54% in thyme essential oil.[20] Halothane, which is thought to be safe, demonstrated similar solvency in this investigation as that of other solvents.

Due to their similar solvent capabilities to the other organic solvents we looked into, we may employ halothane and orange oil in clinical settings for a longer amount of time. Chemical pericementitis is a condition where the apical region develops an unregulated field due to the unpredictability of the miscibility and penetration depth of solutions like xylene and chloroform.[21,22]

When selecting the optimum solvent for endodontic retreatment, it is important to strike a balance between the degree of clinical safety, the degree of toxicity and aggression to the tissues, and the chemical capacity of dissolution.

5. Conclusions

These findings were reached within the constraints of this in vitro study.

Better solvent effect was provided by xylene.

Similar solvent effects were seen with halothane, orange oil, and chloroform.

Solvents with hazardous and cancer-causing properties should only be used in small amounts in clinical settings.

6. Source of Funding

None.

7. Conflict of Interest

None.

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