Effect of organic solvents on removing Gutta-percha obturation and dentin bond strength (An In Vitro study)

Thesis
submitted to the Faculty of Dentistry,
Ain Shams University

For
Fulfillment of Requirements of the master degree
in Endodontics

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2017

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Root canal therapy, despite having a high degree of success, may not lead to the desired response, and failure may occur. The success of root canal treatment depends on completely cleaning and shaping, and then filling the root canal systems. If these parameters are not achieved, post-treatment disease may occur because of the persistence of bacteria in the root canal system.[1]

When root canal therapy fails, the treatment options are conventional retreatment, peri-radicular surgery or extraction. Nonsurgical retreatment should be considered as the treatment of choice for the majority of failed endodontically treated teeth since it is considered the most conservative method to eliminate the microbial infection.

There are several methods for removing the filling materials such as using of solvents, heat and mechanical instrumentation either alone or in combination with each other.

In root canal retreatment, solvents are often used as an aid for removing gutta-percha. Chloroform, an organic solvent, has been shown to be the most effective when used with gutta-percha and most filling materials when compared with other solvents.

Nowadays, the procedures of retreatment have become even more important in endodontics, replacing traditional surgical methods. Different solvents have been largely used to empty the root canal. Their properties should be taken into consideration regarding their effectiveness in the dissolution of the endodontic filling material.

During root canal retreatment, the root and coronal dentine are exposed to gutta-percha solvents deposited in root canals[2] which may alter the chemical composition of dentine surface and affect bond strength of restorative materials to dentine.

However, there is little or no information about the effects of various gutta-percha solvents used on the bond strength of sealers to root dentine.

It is worth studying the push-out bond strength of resin-based endodontic sealer to root dentine exposed to different essential oils gutta-percha solvents. The null hypothesis is that various gutta-percha solvents do not affect the bond strength of several root canal sealers.

Nonsurgical retreatment is the treatment of choice following re-infection, inflammation, or pain due to the persistence of residual necrotic tissues, or bacteria. The retreatment procedure comprises removal of existing old filling material to regain access to the entire canal, expose remnants of necrotic tissue and micro-organisms and facilitate their removal.[3]

- **Methods of gutta-percha removal:**

For a successful orthograde retreatment, the removal of the endodontic filling material, such as gutta-percha, is essential to allow access to the canals for a successful debridement and re-obturation of the root canal system.[4]

One of the great advantages of using gutta-percha for root filling is its relative ease of removal; it is relatively easy to remove gutta-percha—sealer using a combination of heat, solvents, and mechanical instrumentation.[5,6]

Several techniques have been proposed to remove gutta-percha filling materials from root canal system, which are classified into thermal, mechanical and chemical including the use of heated instruments, Nickel-Titanium rotary instruments, and use of adjunctive solvents which facilitate filling removal and penetration of manual and rotary instruments as well as endodontic irrigants.[7]

Removal techniques are dependent upon canal size and anatomy, canal third, well condensed or aged gutta-percha, quantity of gutta-percha present and whether the existing gutta-percha is over or under-extended relative to the apical foramen.[8,9]

Sealers used in conjunction with gutta-percha may remain inaccessible to mechanical removal when they are in anatomical ramifications.[10] In such cases, solvents are essential for the thorough cleaning of filling material/debris and effective disinfection of the root canal system like chloroform, methyl-chloroform, eucalyptol, halothane, rectified turpentine, xylol, orange oil and grapefruit oil.[11]

There are also dangers of using purely mechanical means to remove gutta-percha, as root perforation, canal straightening, or altering the original canal shape.[12] In order to remove filling materials without damage to the tooth, chemical solvents are used to solubilize gutta-percha.

- **Different types of Organic solvents:**

Organic solvents play a vital role in the thorough removal of endodontic sealers. This facilitates the effective disinfection of the root canal system and thus the probability of long-term treatment success.[13]

The most commonly used solvents in the past were chloroform, eucalyptol and turpentine oil.

- **Chloroform**

Chloroform being the gold standard due to its effectiveness in dissolving and removing maximum gutta-percha in a minimum time has been widely used.[14] However, it is classified as a group 2B carcinogen by the International Agency for research of cancer.[15]

In spite of its excellent clinical performance chloroform was shown to have a high toxicity and to be a potential carcinogen and therefore in 1976, the US Food and Drug Administration banned the clinical use of chloroform in drugs and cosmetics.[16] There was no associated ban on its use in dentistry; however, the report did result in the search for alternatives but none was proved to be effective as chloroform.[17]

In the recent studies, orange oil was found to be more compatible than chloroform and eucalyptol. In another study, orange oil performed equally to chloroform and eucalyptol.[18]

- **Orange oil**

Orange oil comprises limonene, aliphatic hydrocarbon alcohols, and aldehydes such as octanal.[19]

It serves as a good replacement for chloroform and xylene for GP softening and removing endodontic sealers in retreatment. Orange oil does not have any harmful effect, has low solubility in water, and is soluble in alcohol. It is used in pharmaceuticals for fragrance and flavor and also has an expectorant action.

Although a recent study concluded that xylene was the most effective in dissolving root canal sealers than other organic solvents, essential oils (orange oil) were found similar in their ability to dissolve filling materials.[14]

It was concluded that xylene, refined orange oil, and tetra-chloro-ethylene can be used for softening canal filling materials during retreatment with various techniques.[20]

Orange oil is an excellent alternative solvent as compared to potentially toxic solvents, being used either on different types of cement to soften and dissolve GuttaPercha.[21]

○ Action of the organic solvents on gutta-percha

Wourms et al[12] evaluated the effect of different organic solvents in dissolving Gutta-percha. The solvents were selected on the basis of their chemical similarity to chloroform or their ability to dissolve any of the ingredients of Gutta-percha. The weight of Gutta-percha samples was standardized. Ten samples of Gutta-percha were tested in 5 ml of distilled water to serve as the negative control. The solubility of another 10 samples of Gutta-percha was tested in 5 ml of chloroform to serve as the positive control. Results revealed that there was no significant difference between dissolving times of chloroform and trichloroethylene at 22 and 37C. At 37 C, Halothane (Fluothane) was twice as effective as cineole.

Ladley et al[8] compared halothane and chloroform used with hand or ultrasonic instrumentation to remove Gutta-percha and sealer from root canals. One hundred four extracted human maxillary anterior teeth with straight canals were obturated with a modified lateral condensation technique. The lengths of the filled canals were standardized. The teeth were assigned to one of four retreatment groups. In group 1 (control), hand instrumentation with K-files was used in conjunction with chloroform. In group 2, Halothane was used as the solvent. Dry ultrasonic instrumentation was used with chloroform for group 3 and Halothane for group 4. Results revealed that all no significant differences between the Halothane and

Chloroform were found. Halothane was found to be an acceptable alternative to chloroform for removing Gutta-percha and sealer from the obturated root canal.

Hunter et al[22] compared the effectiveness of Halothane, Eucalyptol, Chloroform in softening Gutta-percha in simulated root canals. One milliliter of a solvent was placed into a small glass funnel whose stem was obturated with a 30-mm column of gutta-percha. After 30s, softening was evaluated for each solvent by recording the time required to reach a depth of 10 mm by hand filing with a Hedstrom file. Statistical comparisons among the three chemical solvents showed no differences. Although Halothane was significantly less effective than chloroform in softening Gutta-percha, the difference between Halothane and Eucalyptol or between Eucalyptol and chloroform was not significant. The results indicate that Halothane and Eucalyptol are suitable alternatives to chloroform as Gutta-percha softening solvents.

Kaplowitz[23] evaluated the ability of essential oils to dissolve Gutta-percha. Eighteen essential oils were prepared for this study. Samples were prepared using step-back flared technique and obturated. Retreatment of all groups was done using Eighteen essential oils. There were only two possible outcomes: either the Gutta-percha was completely dissolved by the solvent or it was not. Complete dissolution was defined as no visible fragments of

undissolved gutta-percha remaining on the filter paper in the bottle or on the cap. Results revealed that all chloroform and rectified turpentine samples demonstrated complete dissolution of Gutta-percha. There was no significant difference between chloroform and turpentine oil in their ability to dissolve Gutta-percha. The other seventeen essential oils consistently failed to completely dissolve the Gutta-percha.

Zuolo et al[24] conducted a study to quantify the amount of remaining Gutta-percha/sealer after retreatment with a lateral condensation technique. Forty-five extracted mandibular premolars were prepared using step-back flared technique and obturated. Retreatment of all groups was done using an orange oil organic solvent technique. The teeth were split longitudinally and photographed, quantified using a computerized image analysis system and the ratio of remaining obturation material to root canal periphery was derived and statistically analyzed. Results showed that no differences among the techniques when the average percentage of Gutta-percha/sealer was compared.

Uemura et al[25] conducted a study to evaluate Eucalyptol and D-limonene for their ability to serve as a substitute solvent for chloroform. Uniform straight canal was prepared with a step-back technique with a working length of each canal of 18 mm then obturated. The instrumented canal was divided into four equal

groups. Results revealed that the different solvents didn't have a significant difference from chloroform.

Hansen[26] assessed the ability of Eucalyptol oil, chloroform, orange oil, or xylene solvents to allow the passage of an endodontic file through different endodontic sealers and the root filling material Gutta-percha. The forty samples with straight root canals were prepared and then obturated. A size 25 Hedstrom file was used to attempt penetration into the test sample. The times taken to penetrate the length of the tubes were recorded. Results revealed that there was no significant difference in the ability of the solvents to dissolve Gutta-percha and the zinc oxide-eugenol-based sealer.

Kazumi et al[27] evaluated the efficiency of four different solvents and their action on gutta-percha removal. Four solvents were tested: xylol, eucalyptol, orange oil and halothane. Twenty #40 master cones were analyzed at intervals of 1,5,10 and 15 minutes, resulting in five samples for each interval. It showed that xylol was the most rapid for the 5-minute interval. All solvents, after 10 and 15 minutes of action, had dissolving power on the gutta-percha, but orange oil was the solvent that proved to be the most efficient at the end of the studied intervals, followed by xylol, eucalyptol, and halothane in that order. In this way, they concluded that orange oil was the solvent that showed the most efficient result on the gutta-percha.