Comparative evaluation of resilon and guttapercha dissolving qualities in various endodontic solvents-an in-vitro study

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Abstract

Back ground: An invitro study was conducted to comparatively evaluate the dissolving qualities of Resilon and Gutta percha in various endodontic solvents such as Chloroform, Halothane, Eucalyptol oil and Xylene.

Materials and Methods: Ten standardized samples each of Resilon and Gutta percha were tested in 5 ml volumes of Chloroform, Halothane, Eucalyptol oil and Xylene for upto 45 minutes at room temperature to investigate their potential for clinical use in dissolving Resilon and Gutta Percha. Each sample was weighed initially before immersing in the solvent. The time required for the entire sample to completely dissolve was recorded. The rate of solubility was recorded in minutes and seconds.

Results: Mean time taken dissolve Guttapercha by chloroform halothane and xylene is 4,13.06,33.5 minutes respectively. Eucalyptol oil could not dissolve Guttapercha in 45 minutes. Mean time taken to dissolve Resilon by chloroform, halothane and xylene is 2.3,3.6,10.8 minutes respectively. Eucalyptol oil did not dissolve Resilon.

Conclusion: Within the limitations imposed by this invitro investigation, the present study suggests that Chloroform, Halothane, and Xylene can be used for softening Gutta percha/ Resilon during retreatment with various techniques. Eucalyptol oil can be used for softening Gutta percha but takes longer time and cannot be used for softening Resilon.

Keywords: Retreatment, Solvents, Guttapercha, Resilon.

Introduction

Non surgical endodontic retreatment is an attempt to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated root canal system because of coronal or apical leakage. It requires regaining access to the entire root canal system through removal of the defective root canal filling, further cleaning and shaping if required and reobturation.[(1)] Success rate of endodontically treated teeth ranges from 86% to 95%[(2,3)] and retreatment should be done for failure of root canal treated teeth.

For over 100 years, gutta percha has been the most commonly used material to obturate the root canal system. Although not the ideal filling material Gutta percha fulfills many of the characteristics that Grossman in 1940.[(9)] One of the disadvantages of Gutta percha as an obturating material is the lack of an effective seal.[(10)] However, when the coronal restoration is defective or absent, contamination with saliva may cause root canal sealer dissolution, thus providing a space for bacterial penetration that may contribute to the failure of the treatment.[(11)] In addition, dentin removal during root canal treatment has been shown to weaken teeth and make them more susceptible to fracrure.[(12,13)] Obturation with Gutta-percha does not reinforce the remaining root canal dentin. Therefore, Gutta percha filled teeth may be prone to fracture than intact teeth.[(14)]

Recently a new root canal filling material, Resilon is introduced which is a thermoplastic synthetic polymer based root canal filling material containing bioactive glass and radioopaque fillers.[(15)] The manufacturer claims that its handling characteristics are similar to gutta percha. The significant improvement of Resilon when compared to Gutta percha is claimed to be its bonding to the dentin walls when used in conjunction with its sealer, and forms a "monoblock" within the canal.[(16)] Preliminary studies have shown that Resilon has less microleakage when compared to Gutta percha.[(15,17)] A study by Tay et al[(18)] concluded that neither gutta percha with AH plus sealer or resilon with Epiphany root canal sealer provided a complete seal; however, the authors suggest that an advantage of using Resilon with Epiphany root canal sealer over gutta percha and sealer is in the attainment of an "immediate coronal seal" because of the systems dual cure characteristics. Canals obturated with Resilon have also been shown to be more resistant to fracture when compared to Gutta percha.[(16)]

Because of its acclaimed superior characteristics, Resilon is emerging as a promising alternative to Gutta percha. The number of teeth obturated with Resilon is expected to rise significantly in the near future. Although the long term success rate of this new system is unknown, a number of reasons will necessitate retreatment of Resilon filled teeth. The complexity of the root canal anatomy, the breakdown of the seal provided by the obturation and/or restoration of the tooth, or an inadequate initial root canal treatment may lead to non healing.[(19)] A recent study demonstrated the susceptibility of biodegradation of resilon by "bacterial/ salivary enzymes.[(20)] In such cases non surgical endodontic retreatment would be indicated to clean and shape the previously root treated tooth.

Gutta percha, in combination with sealers, is most commonly used material for root canal filling.[(4)]

Removal of Gutta percha can be done with several techniques. These include rotary files, ultrasonic instruments, hand files in combination with heat or chemicals.[5]

Solvents have been used in the past to soften and dissolve Gutta percha.[6,7,8] However, all solvents are known to be toxic to the periapical tissues and should be used with caution.[6,7] Various solvents available for dissolution of gutta percha are: (a) Chloroform (b) Eucalyptol (c) Xylene (d) Methylechloroform (e) Halothane (f) Turpentine oil (g) Pine needle oil and (h) white pine oil. Chloroform is the most commonly used solvent, due to its effective dissolution.[6,7,8]

In clinical practice Chloroform is the most effective and most widely used solvent for Gutta percha, other solvents include Eucalyptol oil, Halothane and Xylene. There are no studies using above solvents to remove synthetic polymer based root canal filling material.

Hence the purpose of this study is to compare and evaluate the dissolving capability of various endodontic solvents such as Chloroform, Halothane, Eucalyptol oil and Xylene on Resilon and Gutta Percha.

Materials and Methods

An invitro study was conducted to comparatively evaluate the dissolving qualities of Resilon and Gutta percha in various endodontic solvents such as Chloroform, Halothane, Eucalyptol oil and Xylene.

Methods: Ten standardized samples each of Resilon and Gutta percha were tested in 5 ml volumes of Chloroform, Halothane, Eucalyptol oil and Xylene for upto 45 min. at room temperature to investigate their potential for clinical use in dissolving Resilon and Gutta Percha. Each sample was weighed initially before immersing in the solvent.

Ten samples of each solvent were prepared in the following manner. 5 ml volume of each solvent were placed into a 10 ml scintillation vial. Immediately after the Gutta percha/ Resilon cone was immersed in the solvent, timing was started with a stop watch and the lid of the screw top bottle will replaced. If the gutta percha/ resilon sample stuck to the glass vial during testing, it was dislodged with vibrations on minishaker to prevent clumping of partially dissolved Gutta percha/Resilon respectively

The Experimental Groups are:
In Group I Chloroform was used as solvent for Gutta percha, **Group II** Chloroform was used as solvent for Resilon, **Group III** Halothane was used as solvent for Gutta percha, **Group IV** Halothane was used as solvent for Resilon, **Group V** Xylene was used as solvent for Gutta percha, **Group VI** Xylene was used as solvent for Resilon, **Group VII** Eucalyptol oil was used as solvent for Gutta percha, **Group VIII** Eucalyptol oil was used as solvent for Resilon

Evaluation: The time required for the entire sample to completely dissolve was recorded. The end point for solubility was taken as that point where there was no solid material detected. The rate of solubility was recorded in minutes and seconds. Only samples that dissolved within 45 minutes were analyzed statistically. If Gutta percha or Resilon did not dissolve completely after the given time period the specimen was obtained and placed on blotting paper to remove the solvent and the remaining amount of Gutta-percha/ Resilon was weighed.

Results and Statistical Analysis

The values obtained for the dissolution of Gutta percha as well as Resilon in various solvents were compared and statistically analysed. Group wise assessment of time taken by Gutta percha/ Resilon to dissolve in the solvents (Chloroform, Halothane, and Xylene, Eucalyptol oil) was recorded in minutes

Since the values of the standard deviation of the experimental groups were very high, the usual parametric tests could not be performed; so non parametric tests were used. **Kruskal Wallis** was used to evaluate the significance of difference in the values of the mean time period taken for dissolution within the groups (intra group comparison).

Mean time taken dissolve Guttapercha by chloroform halothane and xylene is 4,13.06,33.5 minutes respectively. Eucalyptol oil could not dissolve Guttapercha in 45 minutes.

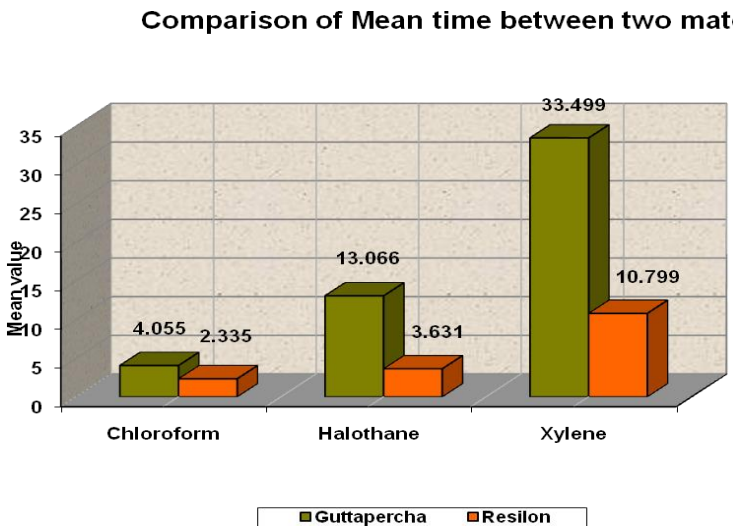
Mean time taken to dissolve Resilon by chloroform, halothane and xylene is 2.3,3.6,10.8 minutes respectively.Eucalyptol oil did not dissolve Resilon. **(Table 1, Graph 1)**

Table 1

Material[a]		N	Mean	Std. Deviation	H	p
guttapercha	Chloroform	10	4.0550	.46586	25.82	0.001 vhs
	Halothane	10	13.0660	.91816		
	xylene	10	33.4990	2.07722		
resilon	Chloroform	10	2.3350	.13874	25.81	0.001 vhs
	Halothane	10	3.6310	.34233		
	xylene	10	10.7990	.66300		

a. Kruskal -wallis test

Graph 1



Discussion

Non surgical endodontic retreatment is an attempt to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated root canal system because of coronal or apical leakage.

It requires regaining access to the entire root canal system through removal of the original root canal filling, further cleaning and reobturation.[1] Earlier studies suggest that the success rate of conventional root canal treatment falls within the range of 53% to 95%. This may be attributed to a wide array of reasons. Some of the significant reasons include the frequency of recall evaluations, operators ability tooth selection, number of cases evaluated, patients subjective response to and compliance with treatment, method of determining failures, and subjective interpretation of results.

There are certain factors, that consistently influence the success or failure conventional root canal treatment like the Presence of Periapical pathosis, latrogenic procedural errors and length of the observation period, the extension of the filling material, quality of the obturation, case selection root canal system anatomy, inadequacy of cleaning and shaping,. At presently it is believed that the most important cause of failure is recontamination of the entire root canal system resulting from coronal bacterial leakage.[39]

Non surgical endodontic retreatment of previously filled root canals is the initial treatment of choice for the management of endodontic failures. Removing as much sealer and filling material as possible from inadequately prepared and filled root canal is critical to uncover the remnants of necrotic tissue or bacteria that may be responsible for perapical inflammation and subsequently failure.[35]

There are several methods for removal of Gutta-percha during retreatment procedures. Which method to adopt depends on the initial examination, quality and length of the filling material. The fastest way to retreat a canal is to pull out the gutta-percha. This is especially true when the canal is not condensed well. Using any type of forceps or a Hedstroem file can remove the filling material immediately. However when the gutta-percha is well condensed, it may necessitate the use of other instruments and techniques to facilitate removal.[3] Removal of coronal portion of the gutta-percha can be achieved with heat carriers such as Touch N. Heat, or System B. Gates Glidden burs also are quite effective in the removal of the coronal portion of the filling material.[39] Recent studies have demonstrated the successful use of Nickel Titanium rotary files as well.[39] Solvents have been used in the past to soften and dissolve Gutta-percha. Solvents available for dissolution of Gutta-percha filling material are as follows, Chloroform Eucalyptol oil, Xylene, Halothane, Turpentine oil, Pine needle oil.[5-8]

When small, underprepared and curved canals need negotiation, solvents and small K-type files are best suited. The sequential technique involves refilling the created reservoir in the canal orifice with drops of solvent and picking into the dissolving gutta-percha while filing with a size 10,15 and 20 stainless steel files. This is continued until the terminals is negotiated after which all the solvents should be discontinued. Sequentially larger K-type files are then inserted into the canal until all the Gutta-percha mass is removed. In many cases combined use of different techniques may be the most efficient and time saving method.[39]

Recently a new root canal filling material, Resilon is introduced which is a thermoplastic synthetic polymer based root canal filling material containing bioactive glass and radioopaque fillers.[4] The manufacturer claims that its handling characteristics are similar to gutta-percha. The significant improvement in Resilon when compared to gutta-percha is claimed to be its bonding to the dentinal walls when used in

conjunction with its sealer, Epiphany root canal sealer, forms a monoblock with the canal.[16] Because of its acclaimed superior characteristics, Resilon is emerging as a promising alternative to gutta-percha. The number of teeth obturated with Resilon is expected to rise significantly in the near future. Although the long term success rate of this new system is unknown, a number of reasons will necessitate retreatment of Resilon filled teeth. The complexity of the root canal anatomy, the breakdown of the seal provided by the obturation and/or restoration of the tooth or an inadequate initial root canal treatment may lead to nonhealing.[19] In such cases non surgical endodontic retreatment would be indicated to clean, shape and obturate the previously root treated tooth.

So, we conducted a study in our department to comparatively evaluate the dissolving capability of various endodontic solvents such as Chloroform, Halothane Eucalyplol oil and Xylene on Resilon and Guttapercha.

In clinical practice Chloroform is the most effective and most widely used solvent for Gutta percha, other solvents include Eucalyptol oil, halothane and xylene. There are no studies using above solvents to remove synthetic polymer based root canal filling material, Resilon. Tamse et al[7] found that Chloroform was the most effective solvent for all brands of gutta-percha tested. They also reported a difference in solubility between various brands of Gutta-percha. Differences in dissolving efficiency were also reported by Wenberg and Ostravik[24] who compared several solvents in search of alternatives to Chloroform for dissolving Gutta-percha.

Chloroform is the strongest and most commonly used of the solvents and is very effective when used for a short time. Its rapid evaporation also makes it a useful chair side material.[7] However, it has been identified as a potential carcinogen. It is cheaper and easier to obtain because it could be made by distillation of alcohol, water and chloride of lime.[22] Morse and Wilcko[42] investigated its clinical use because the FDA highlighted the possible carcinogenicity of Chloroform. Morse and Wilcko[42] stated that, "after these investigations by the FDA, the US Council on Dental Therapeutics decided to delete Chloroform from the Accepted Dental therapeutics,"' and Mattison et al[52] stated that," in view of FDA's ban on the use of chloroform from Accepted Dental Therapeutics, the continued use of this solvent cannot be justified." The accuracy of these statements was questioned by Mc Donald and Vire who pointed out that the ban imposed by the FDA on Chloroform was only for the use in drugs or cosmetics wherein close repeated contact exposure to the skin may pose a problem because of its potential carcinogenicity. It has also been suggested that repeated exposure to Chloroform vapours may have adverse health effects.[6,42] Hence the ban does not pertain to the use of Chloroform in clinical practice and hence it is inappropriate to eliminate the use of Chloroform in dentistry.[41]

Because of concerns of carcinogenicity of Chloroform, clinicians and researchers have developed a renewed interests in finding alternative solvents.[4,24,25] Of the possible alternative solvents to chloroform, Halothane, a fluorinated hydrocarbon used for induction anesthesia seems to be the most promising due to its biocompatibility. It is nearly as effective as Chloroform in dissolving Gutta percha.[25,27] Halothane however is not without any drawbacks. Idiosyncratic hepatic necrosis is a potential side effect following repeated use of halothane induced anesthesia. Idiosyncratic toxicities are a major concern because they are difficult to predict and are usually not present until the patient has been previously exposed to the agent. They are host dependent as well as dose dependent.[31] The incidence of Halothane hepatitis is in the order of one in 10,000 exposures.[31] Therefore with the use of Halothane, it must be recognized that in certain individuals repeated exposures to halothane could initiate a drug hypersensitivity reaction with hepatic necrosis as a sequelae.

The dissolution of Gutta-percha in chloroform is better than that in xylene. For this reason and because of its slow evaporation Xylene is less preferable for use at the chair side. However Chloroform tends to be messy and inconvenient in such procedures as it dissolves rather than softens the Gutta-percha, leaving residues on the walls of the pulp chamber. It is fast evaporating and hence it is necessary to add more and more solvent as soon as it evaporates. Xylene on the other hand dissolves the Gutta-percha more slowly thus allowing a better control and removal of softened rather than liquefied Gutta-percha. Softening and mechanical removal of gutta-percha rather than dissolving it may prove to be not only efficient but also a biologically safer procedure.[32]

This can be accomplished by a cotton pellet moistened with a solvent in the chamber and removing the root canal filling at the following appointment. Because the aged root canal filing tender to become harder and more difficult to remove, such a procedure is of potential importance because it softens the root canal filling slowly before any attempt is done to remove it.[32]

Eucalyptol oil is some what less irritating than Chloroform and it has an antibacterial activity.[24] However it is toxic when ingested[24] and was found to be the least effective among all the Gutta-percha solvent.[7,24] Only when heated can its effectiveness be comparable to that of chloroform. Since it is difficult to apply heat to a patient's tooth, the unheated Eucalyptol oil dissolves Gutta-percha slowly. This significantly increases the chair side time required to remove Guttapercha from the root canal.[24]

Michael et al[31] concluded that miniscule quantities of solvent are expelled through the apical foramen

during the removal of Gutta-percha from the root canal; the amount of solvent that may be extruded to the tissues surrounding the tooth structures in several orders of magnitude below the permissible toxic dose. The controlled use of Chloroform, Halothane or Xylene at the appropriate dose levels as determined by this study poses no health risk to the patient.

The finding in this study indicate that Chloroform is effective in dissolving Gutta-percha compared to Halothane, Xylene and Eucalyptol oil as in most other studies.[25-27,7,29] Halothane showed better dissolving capability than Xylene and eucalyptol oil in dissolving Gutta percha. Xylene showed better results when compared to Eucalyptol oil. However Eucalyptol oil could not dissolve gutta-percha in the tested time period of 45 minutes

In this study a ISO taper size 25 Guttapercha and Resilon were used for checking the dissolution in the respective solvents and did not consider the weight of gutta-percha / resilon although it varied from the specimens in the same lot because the solvent contacts only part of the gutta-percha (surface area); there by dissolving it slowly.[6] The time period taken into consideration was upto 45 min taking into consideration the minimal time taken for removal of gutta-percha from the root canal with solvents and K files.[43]

Evaluation criteria was according to Wourms,[25] the end of solubility was that point where no solid material could be detected and % weight loss according to Tamse et al.[7] For the Eucalyptol oil groups but the weight loss was calculated immediately blotting with absorbent paper, the percentage weight loss is similar to this study but Tamse et al[7] calculated weight loss after the evaporation of the solvent.

Chloroform, with rotary files and without rotary files, was compared earlier with Guttapercha and Resilon removal. These techniques were quicker in removing Resilon compared to Guttapercha. The reason for quicker removal of Resilon may be due to its lower melting point and higher molecular weight than gutta-percha so when subjected to heat, Resilon exhibits higher flowability than Guttapercha.[36]

In our study there is significant difference between Guttapercha and Resilon, in Chloroform, Halothane and Xylene. The reason might be difference in chemical composition of gutta-percha which contains 17% of Gutta-percha, with zinc oxide, zinc silicate forms most of its weight[7] whereas Resilon has thermoplastic synthetic polymer based (polyester) root canal core material containing bioactive glass, bismuthoxy chlorides and barium sulphate. The filler content in approximately 65% by weight Trope et al[4]. May be polyester is rapidly dissolved by solvents because studies have been shown it undergoes biodegradation by bacterial / salivary enzymes.[20]

In our study Guttapercha and Resilon did not dissolve completely in Eucalyplol oil in the allotted 45 minutes time period, but gutta-percha is partially soluble in Eucalyptol oil, this may be attributed to the difference in chemical composition of the material.

Conclusion

Within the limitations imposed by this invitro investigation, the present study suggests that Chloroform, Halothane, and Xylene can be used for softening Gutta percha/ Resilon during retreatment with various techniques. Eucalyptol oil can be used for softening Gutta percha but takes longer time and cannot be used for softening Resilon.

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