Evaluation of chemical substances used as solvents in endodontic retreatment

Carlos Alberto Herrero de MORAIS¹
Marcos Sérgio ENDO¹
Marcelo CAPITÂNIO¹
Marco Antonio Húngaro DUARTE²
Alfredo Franco QUEIROZ¹

ABSTRACT

Introduction: The solvent power of chemicals used in endodontic retreatment is an important property related to the quality of filling material removal. Objective: To compare the solvent power of five substances used in endodontic retreatment after contact with gutta-percha. Methods: A total of 18 gutta-percha cones (#80), weighed on a precision analytical scale and divided into six groups were used: I) chloroform; II) eucalyptol; III) xylool; IV) halothane; V) d’limonene; VI) saline solution (negative control). The cones were immersed in 5 mL of each substance tested inside closed amber glass, and kept in contact at 37 °C for 15 minutes. After this period, 5 mL of saline solution was added to each vial shaken manually for five seconds. Cones were then filtered through absorbent paper. Fragments remained at room temperature for 48 hours, then removed from the filters and reweighed. Data were tested by ANOVA and Kruskal-Wallis test (p = 0.05) was applied to compare the groups. Results: Chloroform (0.04383 ± 0.01831) showed higher solvent power, followed by d’limonene (0.0608 ± 0.01103), xylool (0.06227 ± 0.004015), halothane (0.0653 ± 0.005373) and, finally, eucalyptol (0.0699 ± 0.0006083). Only the chloroform group was significantly different from the control group (p = 0.0431). Conclusion: None of the solvent solutions have completely dissolved gutta-percha, but all promoted its plastification.

Keywords: Retreatment. Solvent solutions. Gutta-percha.

DOI: https://doi.org/10.14436/2358-2545.7.3.062-065.oar

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

Submitted: November 21, 2016. Revised and accepted: May 08, 2017

Contact address: Carlos Alberto Herrero de Morais
Rua Macapá, 63, Jardim Social, Maringá/PR – CEP: 87.010-010
E-mail: caherrero@endodontiamaringa.com.br

¹Universidade Estadual de Maringá, Departamento de Odontologia (Endodontia) (Maringá/PR, Brazil).
²Universidade de São Paulo, Faculdade de Odontologia de Bauru, Endodontia (Bauru/SP, Brazil).
Introduction

Endodontic retreatment is the first choice, especially in cases in which infectious process continued by the persistence of microorganisms in the root canal and periapical tissues. This procedure requires new access to the root canal with the objective of removing all filling material, cleaning, shaping and filling the root canal. It is important to emphasize that efficacy of removal is associated with a more favorable prognosis.

Complete removal of filling material is extremely difficult. Several techniques can be used for removal of gutta-percha, including manual stainless steel files, NiTi rotary instruments, heated condensers and ultrasonic methods. In addition, the use of solvent solutions is recommended to facilitate removal of gutta-percha by plasticizing it.

Solvent solutions are a class of compounds applied during endodontic retreatment to reduce resistance of filling material in root canal walls, thereby not damaging the tooth. Sometimes these substances need to be changed during removal of filling material until the endodontic instrument reaches the apical foramen.

Chloroform has been used since 1850 and is an excellent solvent, but its use has been banned in the United States since 1976 because of its carcinogenic potential. Eucalyptol is an alternative to chloroform as a gutta-percha solvent. During the 20th century, other solvent solutions were created: xylol, eucalyptol, halothane, turpentine, orange oil, and d’limonene, all with the aim of minimizing retreatment clinical time and providing less aggression to periapical tissues. Xylol is an effective solvent, but it exhibits cytotoxicity. Halothane is an anesthetic drug used in Veterinary Medicine and a good solvent of gutta-percha. Substances derived from orange peel, such as orange oil and d’limonene, are being used and studied due to being more biocompatible.

Therefore, the purpose of this study was to compare the solvent power of five chemical substances (eucalyptol, xylol, chloroform, halothane, and d’limonene) used in endodontic retreatment after contact with gutta-percha.

Material and methods

This study used 18 cones of gutta-percha (# 80, Dentsply Indústria e Comércio Ltda., Petrópolis/RJ, Brazil). After being weighed on a precision analytical scale (Micronal S/A, São Paulo/SP, Brazil), they were divided into six groups with three specimens each, according to the substance used (Table 1).

Gutta-percha cones were immersed in a closed amber glass with 5 mL of the respective substance tested, remaining in contact for 15 minutes at 37 °C. After this time, 5 mL saline solution was added to each vial, shaken manually for five seconds. The cones were then removed from the vials and filtered through absorbent paper. Fragments remained at room temperature for 48 hours until total evaporation, and then were weighed again.

Data were evaluated by ANOVA statistical test, and comparison between groups was carried out by Kruskal-Wallis test at significance level of $p = 0.05$.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline solution</td>
<td>Eurofarma Laboratórios S.A., Ribeirão Preto – SP, Brazil</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Las do Brasil Comércio de Produtos Analíticos e Laboratoriais Ltda, Goiânia - GO, Brazil</td>
</tr>
<tr>
<td>Eucalyptol</td>
<td>Biodinâmica Química e Farmacêutica LTDA, Ibiporã - PR, Brazil</td>
</tr>
<tr>
<td>Xylol</td>
<td>Quimesp Química, Guarulhos - SP, Brazil</td>
</tr>
<tr>
<td>Halothane</td>
<td>Cristália - Produtos Químicos Farmacêuticos Ltda, Itapira - SP, Brazil</td>
</tr>
<tr>
<td>D’Limonene</td>
<td>Cocamar, Paranavai - PR, Brazil</td>
</tr>
</tbody>
</table>
Results

Mean and standard deviation values of weights before and after contact of gutta-percha cones with the respective substances indicated chloroform \((0.04383 \pm 0.01831)\) showed higher solvent power, followed by d’limonene \((0.0608 \pm 0.01103)\), xylol \((0.06227 \pm 0.004015)\), halothane \((0.0653 \pm 0.005373)\) and finally eucalyptol \((0.0699 \pm 0.0006083)\) (Table 2). Although all experimental groups of the tested substances promoted plastification of gutta-percha, only chloroform was statistically different from the control group \((p = 0.0431)\).

Discussion

The main objective of endodontic retreatment is to remove filling material from the root canal and reach all canal length up to the apical foramen. Irregularities, such as flat canals, isthmus and branches, can be sources of organic matter and microorganisms. For effective dissolution of endodontic sealers and gutta-percha, the solvent solution can be an aid in the removal of filling material and promote a better cleaning of branches of the root canal system. Due to solvent toxicity, it is recommended to conduct endodontic retreatment without the use of solvent solutions. However, removal of gutta-percha using manual instruments associated with solvent solution has been related to shorter treatment time, especially when filling material was well condensed. Therefore, solvent solutions are employed to reduce resistance of the filling material in the root canal and favor the cleaning of this medium.

Choosing a biologically compatible solvent solution is a challenge. The choice should lie on a safe chemical substance capable of removing gutta-percha. The present study shows one of the most important properties required in endodontic retreatment, which is solvent power. Corroborating the present study, other studies suggest chloroform is the most effective solvent solution in the removal of filling material. It has better solvent capacity when compared to eucalyptol, xylol and halothane; however, it can cause cytotoxicity. Xylol showed intermediate solvent power, although being widely used as chemical solvent, nevertheless, it was considered as carcinogenic as chloroform. Eucalyptol exhibited the worst result, but some authors claim it is an alternative to chloroform as solvent solution.

Halothane is also a solvent solution of gutta-percha, but it is highly volatile, can cause respiratory depression, interfere with hardness of dentin and enamel, and its hepatotoxicity is discussed. Importantly, because those are in vitro studies, solvent power and cytotoxicity may be different from previously mentioned studies, since they do not simulate the actual clinical situation of application of these solvent solutions. Thus, by using a suitable and safe technique, one can achieve satisfactory results and not cause the same cytotoxic injury as observed in the literature.

D’limonene showed performance similar to that of chloroform. This solvent solution is a derivative of orange oil and used in the food and cosmetic industry. Looking for a more biocompatible substance, the study by Uemura et al and Oyama et al reported the favorable solvent power of d’limonene when in contact with gutta-percha, similarly to our findings.

Even with technological advances and the introduction of rotary and reciprocating systems in endodontic retreatment, there is no technique that completely re-

Table 2. Mean values of initial and final weight (mg) of gutta-percha cones, according to each experimental group.

<table>
<thead>
<tr>
<th>Chemical substances</th>
<th>Mean initial weight (mg)</th>
<th>Mean final weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline solution (negative control)</td>
<td>0.0725</td>
<td>0.0725</td>
</tr>
<tr>
<td>Chloroform (positive control)</td>
<td>0.07303</td>
<td>0.04383</td>
</tr>
<tr>
<td>Eucalyptol</td>
<td>0.0724</td>
<td>0.0699</td>
</tr>
<tr>
<td>Xylol</td>
<td>0.0732</td>
<td>0.0622</td>
</tr>
<tr>
<td>Halothane</td>
<td>0.0737</td>
<td>0.0653</td>
</tr>
<tr>
<td>D’limonene</td>
<td>0.0720</td>
<td>0.0608</td>
</tr>
</tbody>
</table>
moves filling material from root canal walls, which justifies the concomitant use of solvent solutions. The combination of automated and manual techniques complemented with ultrasound and/or solvent solutions can be beneficial both in treatment time and removal of filling material, thus, this line of research needs to be maintained in order to improve the cleaning of root canals and reduce tissue damage.

Conclusions
Considering the methods used and according to our findings, it is possible to conclude that:

a) None of the solvent solutions tested completely dissolved gutta-percha, but all promoted its plastification.

b) Chloroform and d’limonene were the most effective solvent solutions, followed by xylol, halothane and eucalyptol.

References