Evaluation of chemical substances used as solvents in endodontic retreatment

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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) xylol; 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), xylol (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.

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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.[1] This procedure requires new access to the root canal with the objective of removing all filling material, cleaning, shaping and filling the root canal.[2] It is important to emphasize that efficacy of removal is associated with a more favorable prognosis.[3]

Complete removal of filling material is extremely difficult.[4] Several techniques can be used for removal of gutta-percha, including manual stainless steel files, NiTi rotary instruments, heated condensers and ultrasonic methods.[5] In addition, the use of solvent solutions is recommended to facilitate removal of gutta-percha by plasticizing it.[6]

Solvent solutions are a class of compounds applied during endodontic retreatment to reduce resistance of filling material in root canal walls,[7] thereby not damaging the tooth.[6] Sometimes these substances need to be changed during removal of filling material until the endodontic instrument reaches the apical foramen.[8]

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.[9] Eucalyptol is an alternative to chloroform as a gutta-percha solvent.[10,11] 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.[9,12] 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.[13]

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 1. Experimental and control groups of analyzed substances.

Substance	Manufacturer
Saline solution (negative control)	Eurofarma Laboratórios S.A., Ribeirão Preto – SP, Brazil
Chloroform (positive control)	Las do Brasil Comércio de Produtos Analíticos e Laboratoriais Ltda, Goiânia - GO, Brazil
Eucalyptol	Biodinâmica Química e Farmacêutica LTDA, Ibiporã - PR, Brazil
Xylol	Quimesp Química, Guarulhos - SP, Brazil
Halothane	Cristália - Produtos Químicos Farmacêuticos Ltda, Itapira - SP, Brazil
D'Limonene	Cocamar, Paranavaí - PR, Brazil

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

Chemical substances	Mean initial weight (mg)	Mean final weight (mg)
Saline solution (negative control)	0.0725	0.0725
Chloroform(positive control)	0.07303	0.04383
Eucalyptol	0.0724	0.0699
Xylol	0.0732	0.0622
Halothane	0.0737	0.0653
D'limonene	0.0720	0.0608

Results

Mean and standard deviation values of weights before and after contact of gutta-percha cones with the respective substances indicated chloroform (0.04383 ± 0.01831) showed higher solvent power, followed by d'limonene (0.0608 ± 0.01103), xylol (0.06227 ± 0.004015), halothane (0.0653 ± 0.005373) and finally eucalyptol (0.0699 ± 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.[6] Irregularities, such as flat canals, isthmus and branches, can be sources of organic matter and microorganisms.[14] 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.[14,15] Due to solvent toxicity, it is recommended to conduct endodontic retreatment without the use of solvent solutions.[12] 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.[16] 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.[15,17] It has better solvent capacity when compared to eucalyptol, xylol and halothane;[11,15,17] however, it can cause cytotoxicity.[12] Xylol showed intermediate solvent power, although being widely used as chemical solvent, nevertheless, it was considered as carcinogenic as chloroform.[18] Eucalyptol exhibited the worst result, but some authors claim it is an alternative to chloroform as solvent solution.[10,11,13] Halothane is also a solvent solution of gutta-percha, but it is highly volatile,[11] can cause respiratory depression,[19] interfere with hardness of dentin and enamel,[20] and its hepatotoxicity is discussed.[21] 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,[22] the study by Uemura et al[13] and Oyama et al[23] 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,[24,25] there is no technique that completely re-

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

1. Lin LM, Skribner JE, Gaengler P. Factors associated with endodontic treatment failures. J Endod. 1992 Dec;18(12):625-7.
2. Stabholz A, Friedman S. Endodontic retreatment — case selection and technique. Part 2: Treatment planning for retreatment. J Endod. 1988 Dec;14(12):607-14.
3. Mounce R. Endodontic retreatment possibilities: evaluation, limitations, and considerations. Compend Contin Educ Dent. 2004 May;25(5):364-6, 368.
4. Só MVR, Saran C, Magro ML, Vier-Pelisser FV, Munhoz M. Efficacy of ProTaper retreatment system in root canals filled with gutta-percha and two endodontic sealers. J Endod. 2008 Oct;34(10):1223-5.
5. Gordon MPJ. The removal of gutta-percha and root canal sealers from root canals. N Z Dent J. 2005 June;101(2):44-52.
6. Taşdemir T, Yildirim T, Çelik D. Comparative study of removal of current endodontic fillings. J Endod. 2008 Mar;34(3):326-9.
7. Bodrumlu E, Er O, Kayaoglu G. Solubility of root canal sealers with different organic solvents. Oral Surgery Oral Med Oral Pathol Oral Radiol Endod. 2008 Sept;106(3):e67-9.
8. Tasdemir T, Er K, Celik D, Yildirim T. Effect of passive ultrasonic irrigation on apical extrusion of irrigating solution. Eur J Dent. 2008 July;2(3):198-203.
9. Kaplowitz GJ. Evaluation of the ability of essential oils to dissolve gutta-percha. J Endod. 1991 Sept;17(9):448-9.
10. Hansen MG. Relative efficiency of solvents used in endodontics. J Endod. 1998 Jan;24(1):38-40.
11. Hunter KR, Doblecki W, Pelleu GB. Halothane and eucalyptol as alternatives to chloroform for softening gutta-percha. J Endod. 1991 July;17(7):310-1.
12. Barbosa SV, Burkard DH, Spångberg LS. Cytotoxic effects of gutta-percha solvents. J Endod. 1994 Jan;20(1):6-8.
13. Uemura M, Hata G, Toda T, Weine FS. Effectiveness of eucalyptol and d-limonene as gutta-percha solvents. J Endod. 1997 Dec;23(12):739-41.
14. Wilcox LR. Endodontic retreatment: Ultrasonics and chloroform as the final step in reinstrumentation. J Endod. 1989 Mar;15(3):125-8.
15. Whitworth JM, Boursin EM. Dissolution of root canal sealer cements in volatile solvents. Int Endod J. 2000 Jan;33(1):19-24.
16. Sae-Lim V, Rajamanickam I, Lim BK, Lee HL. Effectiveness of ProFile .04 taper rotary instruments in endodontic retreatment. J Endod. 2000 Feb;26(2):100-4.
17. Schäfer E, Zandbiglari T. A comparison of the effectiveness of chloroform and eucalyptus oil in dissolving root canal sealers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 May;93(5):611-6.
18. McMichael AJ. Carcinogenicity of benzene, toluene and xylene: epidemiological and experimental evidence. IARC Sci Publ. 1988;(85):3-18.
19. Tabatabai M, Kitahata LM, Yuge O, Matsumoto M, Collins JG. Effects of halothane on medullary inspiratory neurons of the cat. Anesthesiology. 1987 Feb;66(2):176-80.
20. Rotstein I, Cohenca N, Teperovich E, Moshonov J, Mor C, Roman I, et al. Effect of chloroform, xylene, and halothane on enamel and dentin microhardness of human teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999 Mar;87(3):366-8.
21. Pohl LR, Pumford NR, Martin JL. Mechanisms, chemical structures and drug metabolism. Eur J Haematol Suppl. 1996;57(Suppl 60):98-104.
22. Zaccaro Scelza MF, Oliveira LRL, Carvalho FB, Côrte-Real Faria S. In vitro evaluation of macrophage viability after incubation in orange oil, eucalyptol, and chloroform. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Sept;102(3):e24-7.
23. Oyama KON, Siqueira EL, Santos M. In vitro study of effect of solvent on root canal retreatment. Braz Dent J. 2002;13(3):208-11.
24. Taşdemir T, Er K, Yildirim T, Celik D. Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals. Int Endod J. 2008 Mar;41(3):191-6.
25. Souza PF, Gonçalves LCO, Marques AAF, Sponchiado Junior EC, Roberti Garcia LF, Carvalho FMA. Root canal retreatment using reciprocating and continuous rotary nickel-titanium instruments. Eur J Dent. 2015 Apr-June;9(2):234-9.