# Solvency capacity of gutta-percha and Resilon using chloroform, eucalyptol, orange oil or xylene

*Capacidade de solvência da guta-percha e do Resilon utilizando clorofórmio, eucaliptol, óleo de laranja ou xilol*

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## Abstract

**Objective** – The aim of the study was to evaluate the ability of 4 solvents (chloroform, eucalyptol, xylene and orange oil to dissolve gutta-percha and Resilon under two experimental periods (5 and 15 minutes). **Methods** – Eighty pellets of gutta-percha and 80 pellets of Resilon were weighed with a precision balance before and after immersion in solvents during experimental periods of 5 and 15 minutes. The differences between the initial and final weights and resulting losses masses were tabulated. **Results** – The results showed that chloroform presented the greatest ability to dissolve gutta-percha and the polyester polymer Resilon ($p < 0.05$) in both experimental periods. Generally, other solvents currently used clinically (eucalyptol, xylene and orange oil) do not showed adequate ability to dissolve both materials. **Conclusion** – Independent of contact period, the most effective solvency for gutta-percha and Resilon in decreasing order was: chloroform, xylene, orange oil and eucalyptol.

**Descriptors**: Root canal therapy; Retreatment; Solvents; Gutta-percha; Methacrylates

## Resumo

**Objetivo** – Avaliar a capacidade de 4 solventes (clorofórmio, eucaliptol, óleo de casca de laranja e xilol) na dissolução da guta-percha e do Resilon® em dois períodos experimentais (5 e 15 minutos). **Métodos** – Oitenta pellets de guta-percha e 80 pellets de Resilon® foram pesados com uma balança de precisão antes e após a imersão nos solventes pelos tempos experimentais. As diferenças entre os pesos iniciais e finais foram calculadas e o total de massa perdida foram tabulados. R**esultados** – Os resultados mostraram que o clorofórmio apresentou a maior capacidade de dissolver Resilon® ($p < 0,05$) em ambos os períodos experimentais. Sobre a solubilidade da guta-percha, foi observado comportamento semelhante para o clorofórmio, quando comparado aos demais solventes ($p < 0,05$), exceto quando comparado com xilol em 5 minutos. De modo geral, os outros solventes utilizados no estudo (xilol, eucaliptol e óleo de casca de laranja) não mostraram capacidade suficiente para dissolver ambos os materiais de forma adequada. **Conclusão** – Independente do período de contato, a efetividade na dissolução da guta-percha e Resilon® em ordem decrescente foi: clorofórmio, óleo de casca de laranja, eucaliptol e xilol.

**Descritores**:

## Introdução

Although the success rate of the endodontic treatments reached levels of 86% to 93%[1], failures in most cases are associated with undesirable root canal system cleaning or filling that induce to the retreatment[2-3]. Usually retreatment is the first choice because this procedure allows a greater longevity of the dental element in the oral cavity[3].

Gutta-percha associated with a sealer is the most commonly materials used in root canal fillings. It is a consensus that all filling material must be removed in the retreatment that provides adequate disinfection of the root canal system and favors conditions for new filling.

As alternative for root canal obturation, a new system-based on the adhesive principle has been recently introduced, different from the classic concept, is a dual curable dental composite resin sealer based in methacrylate monomers associated to a polyester polymer (Polycaprolactone – PCL) cone called Resilon.

Many solvents are used for gutta-percha removal. Since 1850, eucalyptol and chloroform are widely used as solvents[4], however chloroform has shown better efficiency[5-6]. The chloroform is also indicate in retreatment of teeth obturated with a new material based on polyester polymers called Resilon (Resilon LLC, Madison, CT, USA) which replaces the traditional gutta-percha.

Despite their excellent solvency, chloroform is described as a potential carcinogen by the U.S. Department of Health and Human Services – Public Health Service[7] and the IARC[8] classified as a 2Bgroup. Thus, other solvents had been used by the reason of their low cytotoxicity.

Eucalyptol and orange oil are the only gutta-percha solvents currently available for clinical use that no present potential carcinogenic according the Department of Health and Human Services[7], but few studies evaluated ability of them to dissolve the polyester Resilon[9-10].

Therefore, the purpose of this study was to evaluate the ability of 4 usual solvents to solve gutta-percha and Resilon materials.

## Methods

Eighty Resilon pellets (Resilon LLC, Wallingford, CT) and 80 gutta-percha pellets (Obtura Corp., Fenton, MO) were individually weighed on a precision milligram balance PB153-S (Mettler-Toledo Inc., Columbus, OH) and the initial weights were tabulated.

For our experimental model, sixteen 100mm x 12mm glass petri dishes (Schott AG, Mainz, Germany) received each 10 pushpins (Prayon Metaloplástica Ltda, Blumenau, SC) that were fixed with cyanoacrylate glue (Henkel Ltda, São Paulo, SP) on their covers (Figure 1). After glue setting, pellets were inserted in each pushpin, totaling 8 dishes with 10 pellets of gutta-percha each and 8 dishes with 10 pellets of Resilon each.

**Figure 1. Experimental model. Glass Petri dish with pellets inserted in each pushpin**

The dishes were filled with 4 solvents more commonly used and commercially available: chloroform (Merck KGaA, Darmstadt, Germany), eucalyptol (Biodinâmica Ltda, Ibipora,PR), orange oil (F&A Lab. Ltda, São Paulo, SP) and xylene (Merck KGaA, Darmstadt, Germany). Then, 8 groups (n=10) were immersed into the 4 solvents during 5 minutes and the others 8 groups were immersed during 15 minutes, both at 24 ± 1°C.

After each experimental time, the covers containing fixed pushpins with the materials were removed of solvents and immersed in absolute alcohol during 30 minutes and kept drying at room temperature for 24 hours in order to neutralize the solvent action.

The pellets were carefully removed from the pushpins after drying period and a final weighing was performed using the same balance of precision. The difference between the initial and final weights were tabulated and analyzed statistically using the 1way ANOVA followed by Bonferroni´s multiple comparison test at the level of $\alpha$=0.05 to compare the weight loss after immersion in tested solutions.

## Results

The results showed that chloroform was the solvent that showed the greatest ability of dissolve gutta-percha with statistical difference ($p < 0.05$) in both experimental periods. At 15 minutes, the lesser efficient solvent was eucalyptol and no difference was found between xylene and orange oil.

Regarding Resilon solubility, was observed a greater capacity of chloroform compared to other solvents for both time experimental periods ($p < 0.05$). Although xylene and eucalyptol present solvency for Resilon, there was no statistical difference when compared to the orange oil ($p > 0.05$).

Generally, chloroform was more effective on Resilon and gutta-percha dissolution regardless of experimental periods ($p < 0.05$).

## Discussion

The present results demonstrated that chloroform was an effective solvent for gutta-percha and polyester polymer Resilon.

To assess the solvency, some studies use the methodology of filling material immersion in solvents[9-12].

The use of Resilon or gutta-percha pellets enabled accurate weight measurements after immersion in the period of 5 minutes and 15 minutes. Drying process during 24 hours was suitable to the methodology because in previous pilot study an increase in weight after the immersion was detected in some samples. With this drying step no weight increase was found.

As the chloroform is an organic compound that has ability to dissolve a wide range of organic plastics (e.g. PET, perspex, PVC, polystyrene and PCL polyester) makes it a useful solvent to dissolve gutta-percha and Resilon during endodontic retreatment procedure.

Despite American Food and Drug Administration has determined that chloroform has the potential carcinogen and recommended the suspension of their use in humans, according previous studies, chloroform sho-

**Table 1. Shows the mean weight loose (mg) suffered by gutta-percha pellets in function of contact periods**

| | Gutta-percha | | | |
|---|---|---|---|---|
| Time | Xylene | Eucalyptol | Orange oil | Chloroform |
| 5 minutes | 2,93 ± 0,92$^{a}$ | 0,92 ± 0,35$^{b}$ | 1,24 ± 0,37$^{a,b}$ | 10,16 ± 2,38$^{c}$ |
| 15 minutes | 11,19 ± 6,73$^{A}$ | 1,15 ± 0,65$^{B}$ | 7,03 ± 1,30$^{A}$ | 63,61 ± 5,21$^{C}$ |

Means and standard deviations of gutta-percha's weight loss in function of the contact periods.Different letters (a, b, c, or A, B, C) indicate statistical difference ($p < 0.05$) and equal letters indicate no statistical difference ($p > 0.05$) using 1way ANOVA followed by Bonferonni´s multiple comparison test.

**Table 2. Shows the mean weight loose (mg) suffered by Resilon pellets in function of contact periods.**

| | Resilon | | | |
|---|---|---|---|---|
| Time | Xylene | Eucalyptol | Orange oil | Chloroform |
| 5 minutes | 2,42 ± 0,71a | 1,95 ± 0,29 a | 2,01 ± 0,21a | 81,85 ± 6,48b |
| 15 minutes | 3,21 ± 0,12A | 2,18 ± 0,34A | 2,26 ± 0,37A | 209,5 ± 6,34B |

Means and standard deviations of Resilon's weight loss in function of the contact periods. Different letters (a, b, c, or A, B, C) indicate statistical difference ($p < 0.05$) and equal letters indicate no statistical difference ($p > 0.05$) using 1way ANOVA followed by Bonferonni´s multiple comparison test

wed high solvency capacity of the endodontic filling materials[6,11,13-19]. In addition to chloroform present to be carcinogenicity[20] and cytotoxic agent to the periapical tissue[20-21].

In this study results showed that chloroform was the solvent that showed the greatest ability of dissolve Resilon (Table 2) with statistical difference ($p < 0.05$) in both experimental periods and no difference was found between eucalyptol, orange oil and xylene ($p > 0.05$). As findings from Azar *et al.*[19] (2011), Resilon showed higher solubility than gutta-percha in chloroform.

These results agree with studies by Hassanloo *et al.*[18] (2007) and Kaplowitz[13] (1990). Disagreement studies showed equivalence between all the same solventsused in our study[11] or that xylene or orange oil has better solvency capacity than the others[12,22].

Although the use of chloroform as a gutta-percha and Resilon´s solvent can cause negligible risk to the patient[23-24], your cytotoxicity characteristic leads to demand for alternative solvents.

Some other solvents have been recommended: orange oil[10-11,22,25], eucalyptol[10-11,14], halothane[4,14,16] and xylene[4,9,11-12,22].

Xylene is an aromatic organic solvent that present solvency against hydrocarbons (e.g. gutta-percha) and poliurethanes (e.g. Resilon) probably due to destabilization of the covalent bonds between the carbon atoms[9] but as chloroform, xylene showed cytotoxicity[26].

d-Limonene, is found widely in citrus and many other plant species and is a major constituent of many essential oils (e.g. orange oil) has been extensively studied especially their solvency capacity[9-10,23,27-28].

Eucalyptol and d-Limonene showed to be citotoxicant[21,29] but the orange oil that contains limonene is less cytotoxic when compared with eucalyptol and chloroform[30].

Analyzing solvency on gutta-percha (Table 1) at 5 minutes, our results demonstrated that eucalyptol and orange oil presented similar behavior. This is in agreement with previous studies[9-12] unlike Pecora *et al.*[15] (1993) and Oyama *et al.*[22] (2002) that showed better softening action of orange oil when compared with eucalyptol. Another finding is that no difference was found between xylene and orange oil ($p > 0.05$) that contrast with Magalhães *et al.*[12] (2007) and Tanomaru-Filho *et al.*[9] (2010) that showed more dissolving efficacy of xylene than orange oil. Additionally, according others studies[9,12] xylene was more effective than eucalyptol.

In our results in the period of 15 minutes, xylene and orange oil demonstrated better dissolution than eucalyptol without significant difference ($p > 0.05$) but this solvency capacity is lower than required by the chloroform. This finding disagrees with results obtained by Tanomaru-Filho *et al.*[9] (2010) and Magalhães *et al.*[12] (2007) that showed equality between both solvents.

Against gutta-percha, chloroform was the solvent that showed the greatest ability of dissolve Resilon with statistical difference ($p < 0.05$) in both experimental times, agreeing with previous results[3,18-19].

## Conclusion

Within the limitations of the current study, the findings indicated that chloroform was more effective on Resilon and gutta-percha dissolution ($p < 0.05$). The absence of an ideal balance between biocompatibility and solvency efficiency leads to more researches in order to achieved new solvents with the same solvency capacity of chloroform with less cytotoxic potential.

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Received February 3, 2012
Accepted March 6, 2012