

Using solvents for dissolving guttapercha: A systematic review

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Abstract:

Aim. To assess systematically the available scientific evidence about the efficiency and the adverse effects of different solvents dissolving guttapercha.

Materials and methods. The study of publications was produced in the electronic databases such as Google Scholar, PubMed during a systematic review of the literature. Included articles contain information about using solvents during endodontic retreatment and their effectiveness and side effects. The publication date criterion was selected from January 2006 to January 2021.

Results. 66 articles were viewed during the review. After analyzing the literature for inclusion criteria, the total number of publications has become 13.

Conclusions. According to literature data, the frequency of using essential oils (orange oil, grapefruit oil, eucalyptus oil) to dissolve guttapercha in endodontic practice is increasing due to better biocompatibility and lack of cytotoxicity and carcinogenic effects.

Keywords: solvents, endodontic retreatment, dissolving gutta-percha.

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INTRODUCTION

A certain number of cases do not respond to primary endodontic treatment for many reasons, which makes retreatment necessary. It requires a complete and high-quality removal of the filling material, since a failed root canal treatment will lead to the addition of a bacterial infection and subsequent complications.

Guttapercha is the most common material for high-quality root canal filling [13]. Its removal can be done with chemicals called solvents. However, their use is optional, which makes it possible not to use solvents. Studies have shown that the use of guttapercha solvents not only accelerates the endodontic retreatment process, but also improves the quality of the root canal treatment [33].

Solvents differ from each other in chemical composition, time of achieving their effect, effectiveness, toxic effect on periapical tissues, presence or absence of carcinogenic and hepatotoxic effects.

The purpose of this review article is to analyze the effectiveness and presence of toxic effects when using solvents to dissolve guttapercha.

MATERIALS AND METHODS

This systematic literature review follows Prisma guidelines.

Eligibility Criteria

Publications that met the following selection criteria were included:

1. Publication year isn't earlier than 2006
2. Availability of studies proving the properties of each selected guttapercha solvent
3. Figuring the topic of the effectiveness of using various solvents for retreatment, as well as their side effects on pericardial tissues and internal organs, the presence of studies.

The review didn't include publications, the title and abstract of which did not meet at least one of the presented inclusion criteria.

Information Sources

Up-to-date information in Russian and English from Google Scholar, PubMed electronic databases has been studied.

Search and Selection of Studies

A search in Russian and English with no time limit was performed by one person. Search terms included "retreatment", "solvents", "dissolving gutta-percha", "gutta-percha removal". The studies were filtered and selected in several stages. Firstly, they were evaluated by titles. Secondly, individual documents at the first stage were additionally assessed by reading the abstracts and full-text articles. The first selection criterion was the selection of publications whose titles included at least one search term. Further, publications which are dated earlier than 2006 were excluded. At the last stage, the content of the full-text versions of the selected articles was examined (Figure 1).

Risk of Bias Assessment

Cochrane Collaboration data were used to assess the risk of bias, with tests performed at each of the selection stages, according to Higgins et al [42]. The levels of bias were classified as follows: low risk, if all the criteria were met; moderate risk, when only one criterion was missing; high risk, if two or more criteria were missing; and unclear risk, if there were very few details to make a judgement about a certain risk assessment.

RESULTS

66 articles were reviewed, of which 29 were from the PubMed database, 37 were from Google Scholar. After the selection according to the exclusion criteria, the total number

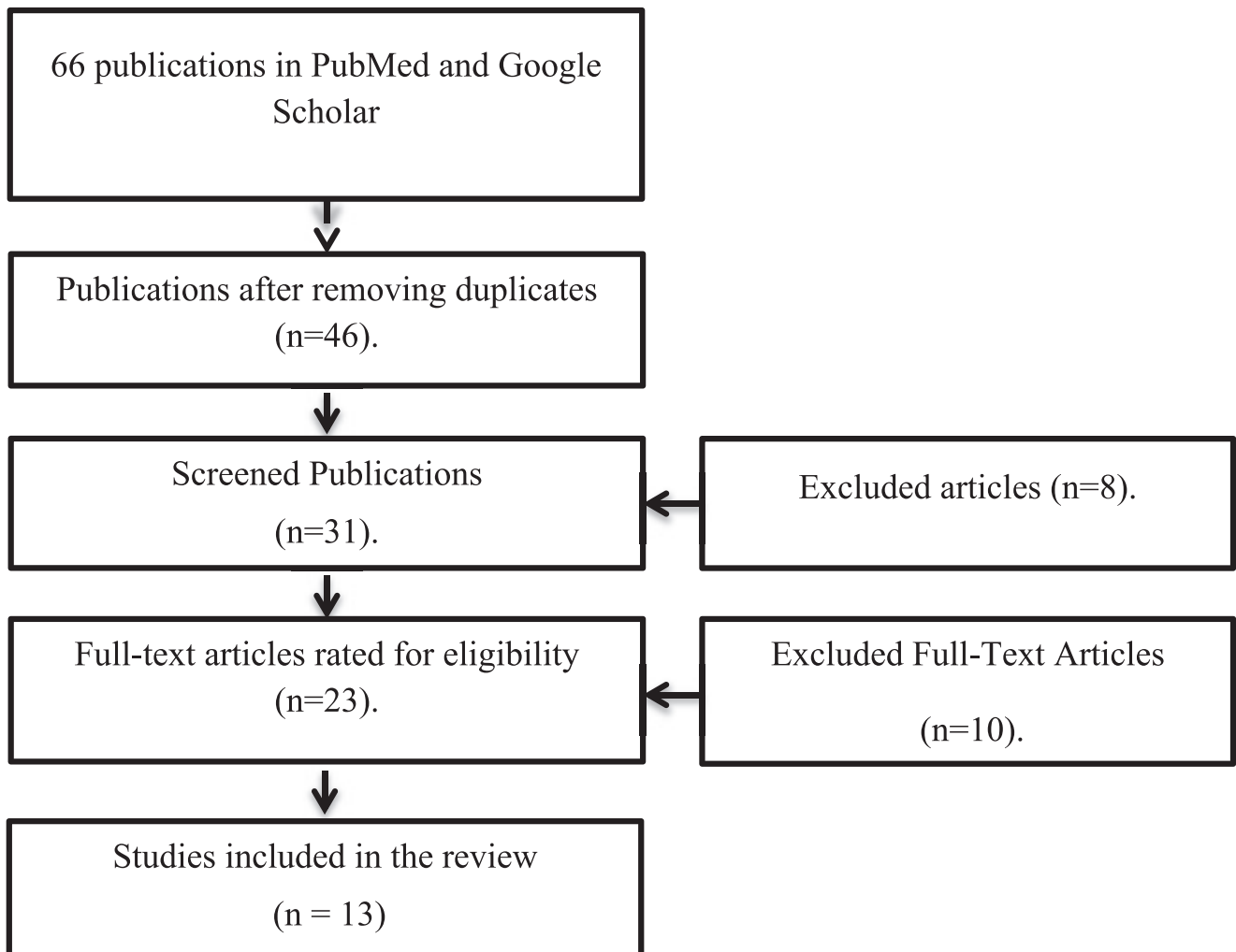


Fig. 1. Article selection process.

of articles was 13. In the selected articles, the relevant data on the effectiveness and side effects of solvents in retreatment were analyzed (Table 1).

DISCUSSION

Guttapercha is one of the most used materials for high-quality root canal filling. The dissolution of the guttapercha for the retreatment can be with or without solvents. Over time, the choice of solvents has changed towards other chemicals due to their better biocompatibility [24]. An ideal endodontic solvent requires the following properties: high dissolving effect, low surface tension, low cytotoxicity, no carcinogenic effects, ease of use, fast action and long service life [23].

Let's consider in more details the properties of various solvents, such as carcinogenicity, cytotoxicity, the ability to dissolve guttapercha and the effect on periapical tissues.

Turpentine

The average percentage of weight loss in guttapercha after 10 minutes was 25.86 ± 0.89 [40].

After 14 days of using turpentine, periodontal tissues are edematous and inflamed in some places, the epithelium is swollen and inflamed. There is damage to the terminal plate of the periodontium, inhibition of the cells of the interstitial substance, the own ligament is vocalized and, in some places, destroyed. The vessels are sharply dilated. The bone tissue of the alveolar process at the site of turpentine injection is loosened and contains the remains of the substance, with the formation of cavities. After one month of using turpentine,

morphological changes are still visible in all periodontal tissues. There is an increase in the number of vessels near the ligamentous apparatus and the appearance of lumps of destructive material of cells and tissues with a brownish color. Young bone tissue without osteocytes with signs of destruction. The ligamentous apparatus is disorganized. The most characteristic changes in the periodontal tissues were found within two months after using turpentine. In the zone of turpentine action on the alveolar bone, there is a frequent appearance of zones of old bone, without remodeling and weak work of osteoclasts for its elimination [10]. Bone lacunas are without cells – osteocytes. Bone beams are wide and dense. The adjacent area around the old bone contains little newly formed new bone. Destruction of the bone alveolar bone was found on most preparations – areas of cancellous bone without osteocytes and with a poorly developed osteoid [5].

Thus, turpentine has a local toxic effect on the surrounding tissues. This effect is due to the fact that turpentine oil, being an organic solvent, has a negative effect on the lipid component of cells and interstitial tissue [5], but has no carcinogenic effect.

Eucalyptus oil

The efficiency is lower compared to chloroform because eucalyptus oil cannot be heated in the root canal. If the temperature of this solvent is raised to 37 degrees, its permeability increases [14, 25].

After a day of using eucalyptus oil, there are signs of inflammation in the periodontium without destructive changes in the bone. After 14 days of using eucalyptus oil there are zones of the ligamentous apparatus, in which the vessels are normally developed, fibrous or other changes identified are absent. The ligament of the tooth is unchanged, without disorganization, with densely packed fibers [10]. One month later, in the area of exposure to eucalyptus oil, it was found that in the area of the alveolar bone there is an active restoration of partially damaged bone tissue, the processes of closing a partial defect are underway, and young osteoid tissue with well-developed vessels is being formed. The old bone is gradually removed. Two months after exposure to eucalyptus oil on the periodontal tissues, it was found that all tissues adjacent to the tooth were practically normal, without fibrotic changes and inflammation. There are no changes found for this observation period under the action of turpentine [5].

The average percentage of weight loss in gutta-percha after 10 minutes was 18.27 ± 0.85 [40]. The surface tension coefficient $\sigma = 49.9 \text{ J / m}^2$ [41].

Eucalyptus oil has a positive antiseptic anti-inflammatory effect on periodontal tissue [24]. Thus, eucalyptus oil is safe to use to dissolve gutta-percha. Eucalyptol achieves the best effect when used on thermoplastic gutta-percha [3] in the apical third of the canal [34].

Chloroform

The average percentage of weight reduction in guttapercha after 10 minutes was 38.87 ± 0.73 [40], which shows the maximum efficiency in dissolving guttapercha among other solvents.

Cofferdam (latex or non-latex) dissolves on contact with chloroform, which creates a number of inconveniences in the work [6]. Chloroform acts on the chemical composition of dentin, changing the content of calcium and phosphorus, and adversely affects the bond strength during stretching of adhesive systems [25]. Nevertheless, chloroform has the most undesirable effects on periapical tissues, and it is also a carcinogenic and neurotoxic substance [26]. Chloroform is classified as a Group 2B carcinogen by the International Agency for Research on Cancer [27, 28].

Xylene

The average percentage of weight loss in gutta-percha after 10 minutes was 28.30 ± 0.97 [40]. One of the most effective solvents for gutta-percha [13]. It dissolves gutta-percha more slowly [36] than chloroform, allowing for better control and removal of the softened gutta-percha.

Has a potentially irritating effect on periapical tissues [3] but does not have a carcinogenic effect [39].

Orange oil

The beginning of softening after 30 seconds, after 60 seconds there is a slight softening of gutta-percha [41]. One of the most effective solvents of gutta-percha in two-thirds of the canal [34]. It is more biocompatible and less cytotoxic than xylene and chloroform [27]. Orange oil achieves the best effect when used on thermoplastic gutta-percha [3]. Orange oil does not affect the tensile bond strength of adhesive systems [25].

The frequency of use of orange oil is increasing in endodontic practice due to its proven safety, biocompatibility and lack of carcinogenic effect [25] and toxic effect on periapical tissues.

Halothane

An alternative to chloroform, is not used because of the potential side effect – idiosyncratic liver necrosis [12], as well as toxicity and carcinogenicity.

Tetrachlorethylene

Tetrachlorethylene showed the lowest average penetration time compared to other solvents [36], which means that tetrachlorethylene has a strong dissolving effect for guttapercha.

It is considered a safe alternative to chloroform compared to halothane. Tetrachlorethylene is the main substance of Endosolv-E (Septodont, Paris, France) [2], which is used to dissolve guttapercha. However, little is known about its effectiveness compared to other solvents. Tetrachlorethylene is not hepatotoxic [12].

Peppermint oil

The average percentage of weight loss in gutta-percha after 10 minutes was 1.76 ± 0.76 [40]. This shows the low capacity of peppermint oil to dissolve the guttapercha mass.

Table 1. ??????

Author	Publication year	Materials	Number	Solvent
Miriam F. Z. S. et al [7]	2008	Ex vivo, Human maxillary canines	40	Chloroform, orange oil, eucalyptol oil
Karina R.S. et al [8]	2019	Human maxillary premolars	40	Chloroform, orange oil, eucalyptol oil
Mona D. et al [17]	2019	In vitro, human maxillary central incisors	30	Chloroform, tetrachloroethylene
Professor CP Owen [20]	2014	GP cones	81	Eucalyptol oil, xylene
Sadashiv G.D. et al [21]	2019	In vitro, GP cones	70	Peppermint oil, castor oil
Kelly C.S. de O. et al [22]	2017	In vitro, GP cones	30	Xylol, eucalyptol, citrol, orange oil
Alberto D. et al [23]	2017	In vitro, GP cones	50	Chloroform, orange oil, a mixture of D-limonene and 1,2-dichloropropane, a mixture D-limonene and turpentine
Zohreh K. et al [32]	2013	In vitro, human mandibular premolars	60	Chloroform
Zivile G. et al [34]	2018	In vitro, human mandibular incisors	40	Orange oil, eucalyptol oil,
Farid G. N. [36]	2013	Human teeth	12	Eucalyptol oil
MH Yosefi Dr [37]	2015	In vitro, human anterior teeth	50	Chloroform, carvene
Atul J et al [39]	2017	In vitro, GP cones	30	Orange oil, xylene
Kumar A et al [40]	2017	In vitro, GP cones	N	Chloroform, rectified white turpentine oil, eucalyptol oil, peppermint oil

The beginning of softening of gutta-percha after 50 seconds, after 60 seconds, slight softening is noted [41].

Grapefruit oil

The beginning of dissolution after 10 seconds, after 60 seconds, complete dissolution of the gutta-percha is noted. Grapefruit oil is the most effective solvent for dissolving gutta-percha in hard-to-reach dental tubules. This is due to the lowest surface tension coefficient of grapefruit oil $\sigma = 26.039 \text{ J / m}^2$, in comparison with other essential oils.

When penetrating into hard-to-reach places, grapefruit essential oil is better than other solvents washed out of them, since it has the best wettability for irrigation solutions, since the wettability of the gutta-percha solvent depends not only on the surface tension of the irrigation solution, but also on the surface tension of the solvent itself.

When using grapefruit oil as a solvent for guttapercha, the percentage of developing an infectious inflammatory process in dentin is reduced. This is due to the increased leachability of the remnants of grapefruit oil and the filling material dissolved by it from the dental tubules [41].

Clove oil

The beginning of softening after 40 seconds, after 60 seconds, partial softening of the gutta-percha mass is noted. The surface tension coefficient $\sigma = 31.58 \text{ J / m}^2$ [41].

There are methods of dissolving guttapercha without solvents, but there are proven studies confirming good effectiveness when using them.

An example is the use of MtwoR and ProTaper in combination with and without a solvent:

1. When working inside the canal using MtwoR without the use of solvents, the mineral component of dentin in the form of hydroxyapatite drusen is visible. The "smeared layer" is also clearly visible on the longitudinal sections of the canal.

When working inside the canal with MtwoR using guttapercha solvents, virtually no "smear layer" is detected,

although sometimes a mineral amorphous structure or small crystals can be observed on the canal surface. At the same time, the dentinal tubules do not contain filling material either in the depth or in the orifices [30].

2. When using solvent with ProTaper, the time for endodontic retreatment is reduced. The heat generated by the rotating instruments helps the solvent to plasticize the guttapercha and facilitates the penetration of the rotating instruments into the guttapercha mass [31].

CONCLUSIONS

The use of solvents statistically significantly facilitates the removal of the filling material in the root canal during endodontic retreatment. Especially, many studies have proven their effectiveness in dissolving guttapercha.

Over time, the choice of solvents has changed due to the research and the results obtained. Previously, chloroform was used due to the high dissolution efficiency of guttapercha and the short time required performing this procedure, but due to its proven cytotoxicity and carcinogenic effect, chloroform is no longer a safe solvent. For its alternative, various solvents of guttapercha were investigated, such as halothane, xylene, purified turpentine oil. However, due to the toxic effect on the periapical tissues, as well as the hepatotoxic effect, these solvents are not used.

Safe alternatives to chloroform are orange, grapefruit and eucalyptus oils, which are essential oils. They have no toxic, carcinogenic and hepatotoxic effects. A positive property of orange oil is its biocompatibility, eucalyptus oil has a positive antiseptic anti-inflammatory effect on periodontal tissue, but it must be heated to 37 degrees to increase permeability. Grapefruit oil penetrates into hard-to-reach places and is also well washed out of them.

The high efficiency of the use of rotating instruments with the use of solvents for endodontic retreatment has been proven.

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