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OPTIMIZATION OF THE ENDODONTIC TREATMENT PROTOCOL USING MICELLAR WATER. *LITERATURE REVIEW*

Zurab Khabadze[1], Irina Makeeva[2], Farukh Ismailov[1], Mikhail Protsky[1], Alexandra Kotelnikova[1], Ekaterina Shylyaeva[1], Daria Nazarova[1]

[1] The Peoples' Friendship University of Russia, Moscow;
[2] The Sechenov First Moscow State Medical University, Moscow, Russia

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khabadze-zs@rudn.ru

ABSTRACT

In the process of repeated endodontic treatment, we are challenged with washing out the oil solvent from the root canal after the dissolution of gutta-percha. Micellar water, consisting of amphiphilic molecules, has not only a higher leaching capacity for the remnants of the material from the dentine tubules, but also is of minimal toxicity to humans. However, micellar water lacks the bactericidal activity, so further studies are needed to optimize the irrigation protocol.

The purpose of this review article is to systematic assessment of scientific data on the use of micellar water in the process of repeated endodontic treatment and its effectiveness

Materials and methods: Electronic search of articles was carried out using search engines and databases Google Scholar, Pub Med, CyberLeninka. The articles are included, the content of deals with the use of micellar water in the process of endodontic treatment. The publication date criterion has been selected since January 2011

Results: 72 articles were reviewed during the review process. After analyzing the literature according to the inclusion criteria, the total number of publications was 50.

Conclusions: Micellar water is a promising tool for root canal irrigation in the process of repeated endodontic treatment. The amphiphilic structure of the colloidal solution micelles helps to reduce the surface tension of the oil solvent, its dissolution and leaching from the root canals.

This irrigant has minimal toxicity and is completely harmless to both the patient and the dentist. However, the absence of a bactericidal effect significantly reduces the quality of drug treatment.

Therefore, further research should be directed to the optimization of this irrigation protocol, the introduction of this method into practice.

Keywords: micellar water, endodontic retreatment, solvent, irrigant, drug treatment, dissolving gutta-percha.

INTRODUCTION

The spread of the carious process deep into the dentin leads to infection of the pulp and the development of its inflammation. At the same time, the pulp tissues disintegrate, the active growth of microflora begins in the tooth cavity and root canals, the formation of toxic substances [17]

If the treatment is not carried out properly, the infectious process spreads beyond the top of the root, bypassing the epithelial barriers into the internal environment of the body [1]. In this case, it is necessary to perform repeated endodontic treatment.

Gutta-percha in combination with various silers is the most common material for high-quality filling of root canals [27]. That is why the problem of re-treatment of teeth whose channels are sealed with gutta-percha has become urgent at the present time. The use of solvents for endogermetics in this case is not very effective, since most of the channels are filled with gutta-percha, and the endogermetic occupies only a small space between the pins. In this regard, the interest of dentists in gutta - percha solvent preparations is increasing [3]. There are several types of solvents, such as essential oils (orange oil, grapefruit oil, eucalyptus oil, purified turpentine oil), as well as tetrachloroethylene, chloroform, which are used to dissolve gutta-percha [8]. The choice of solvent is due to the need for rapid softening of the obturation material and the absence of any complications when the solvent enters the apical delta. As a result of research, it was found that the most favorable effect on tissues is provided by solvents based on essential oils, in particular grapefruit oil [28].

When implementing the claimed method, after the introduction of grapefruit oil into the mouth of the root canal, it is necessary to determine the optimal means for washing out its residues [4].

Drug treatment is carried out by one of the irrigants used in dentistry, for example, sodium hypochlorite, which has bactericidal properties, is not toxic and does not interfere with healing. In addition to its disinfecting properties, sodium hypochlorite has the property of dissolving necrotic tissues [6].

Also, EDTA (ethylenediaminetetraacetic acid) can be used for drug treatment. EDTA is able to demineralize dentin to a depth of 20-50 microns, thus contributing to the removal of the lubricated layer and the opening of the dentine tubules, which, firstly, guarantees a deeper leaching of solvent residues and obturation material from the dental tubules, and secondly, facilitates instrumental processing. During the stage of drug treatment of the canal, the sequence of solutions is observed: hypochlorite; distilled water (necessarily distilled water between solutions, since EDTA neutralizes hypochlorite); EDTA [7].

Another means for washing out the remnants of solvent and obturation material from the dental tubules, which can be used as an alternative or in combination with the above preparations, is micellar water [9]. This irrigation protocol is new in dentistry, so it is necessary to study the physico-chemical properties of micellar water, understand the mechanism of its action in the process of washing out the solvent, and also understand how effective this irrigant is compared to others [10].

Under experimental conditions, the ProTaper universal rotary re-treatment system was also used, it showed better GP removal, and also turned out to be faster in terms of re-treatment time. [11,22].

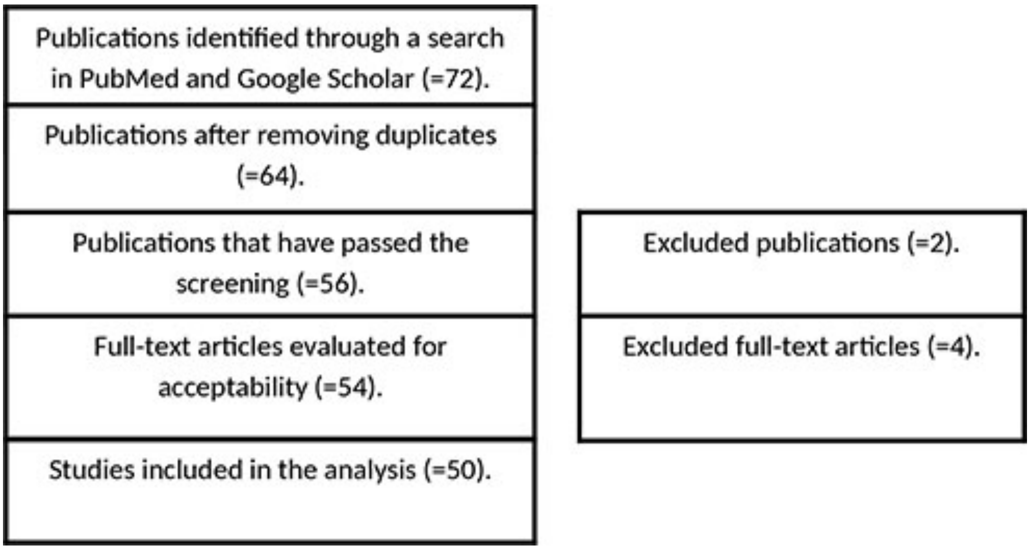
The purpose of the study: a systematic assessment of scientific data on the use of micellar water in the process of repeated endodontic treatment, justification of the use of this irrigant in practice.

MATERIALS AND METHODS

The study of up-to-date information in Russian and English, obtained as a result of a search in the electronic databases Google Scholar, PubMed, CyberLeninka, was carried out.

Search terms included "retreat"," micellar water", "endodontic treatment", "medical treatment", "micellar solutions", "micellar water", "repeated endodontic treatment", "retreat".

Table 1. *Article selection process.*



The selection of publications was also carried out according to the following inclusion criteria – the date of publication of the article no earlier than 2011, the topics of the effectiveness of using various irrigants for dissolving a solvent based on essential oils in the process of repeated endodontic treatment, as well as the physico-chemical properties of micellar water as a surfactant, the presence of studies proving the properties of this solvent.

The first exclusion criterion was the selection of publications dated earlier than 2011. Further, the review did not include works whose title and summary did not meet at least one of the submitted inclusion criteria. At the last stage, the content of the full-text versions of the selected articles was studied.

RESULTS

72 articles were considered, of which 23 were on the PubMed database, 49 - Google Scholar. Having made the selection according to the exclusion criteria, the total number of works was 50. The selected articles analyzed current data on the physico-chemical properties of micellar water, as well as the possibility of using this solution as an irrigant in dental practice for repeated endodontic treatment.

DISCUSSION

The most popular method of root canal obturation is filling with gutta-percha pins, but endodontic treatment is not always successful [12].

Treatment of diseases of the pulp, periodontal and endodontic preparation of teeth to restore their structure and function are the most important part of practical dentistry.

Endodontics is an alternative to tooth extraction, against the background of the growth of caries in the population, it has taken a significant place among dental services in our country. Its main task is to preserve the subject's maximum set of teeth.

The current level of dental health of our population is characterized by their massive loss.

Epidemiological studies have shown that every adult patient has 3-6 teeth requiring endodontic therapy, and 2/3 of them need to be treated.

Modern technologies make it possible to restore even significantly destroyed teeth roots. They make it possible to preserve the unique anatomical structure — the periodontal ligament of the tooth.

Root canal treatment requires good manual skills from the dentist. However, without a correct diagnosis and a clear understanding of the biological foundations, the dentist's technical skills will be uselessly spent on performing complex manipulations or inadequate treatment.

Making the correct diagnosis in combination with the right choice of new materials and techniques creates conditions that allow for a high probability of achieving a successful result and ensuring a healthy state of periapical tissues.

The reasons for the failure of endodontic treatment, as a rule, are biological factors and iatrogenic damage. Unsuccessful treatment is a consequence of a combination of bacterial infiltration of various composition and volume and an ineffective immune response [39].

The solution, in this case, is to correct the error made during the first endodontic treatment, that is, the re-treatment of the root canals [13].

In order to seal the channels, we use various solvents. Recent studies have shown that the most effective substance for dissolving gutta-percha is grapefruit oil [14].

However, we cannot leave the oil solution in the channel before the final obturation, so we need a substance that will wash out the solvent residues from the channels and create favorable conditions for high-quality sealing [15].

Recently, there have been data in the scientific literature on the use of micellar water in the process of medical treatment of root canals during repeated endodontic treatment [18, 19, 48].

Micellar water belongs to the class of surfactants, which we constantly encounter. They are responsible for the cleansing abilities of shampoos, wash and shower gels, washing powders, soaps, etc.A feature of surfactants are the particles of which they consist — micelles [24].

Surfactants include organic substances whose molecules are diphilic, that is, they consist of a polar group (-NH2, -OH, -COON, -COONa, =OSO3Na, etc.) and a nonpolar hydrocarbon radical R (for example, CH3-(CH2)n -). As a rule, surfactants are alcohols, carboxylic acids and their salts, amino acids and their salts. The polar group informs the molecule of its hydrophilic properties and determines its ability to dissolve in water or other polar solvents. The hydrocarbon radical exhibits hydrophobic properties, providing the solubility of surfactants in hydrocarbons (non-polar solvents) [16].

Surfactants can be divided into two groups:

1. Truly water-soluble surfactants are diphilic organic compounds with small hydrocarbon radicals: lower alcohols, carboxylic acids and their salts, amines. The polar groups of these molecules are not sufficiently hydrophilic, and the hydrocarbon radicals are small. At any concentration, they are in the form of a molecular solution [20,46].
2. Colloidal or soap - like surfactants are long- chain diphilic organic compounds with the number of carbon atoms in the radical from 10 to 20. Their molecules have polar groups of high hydrophilicity and sufficiently large hydrocarbon radicals (the number of carbon atoms pS > 10). Colloidal surfactants are characterized by low true solubility (10-5-10-3 mol/l) and high surface activity. Colloidal surfactants include salts of fatty acids(soaps), some dyes, synthetic surfactants, etc [21].

There are ionogenic (dissociating) and non-ionic (non-dissociating) colloidal surfactants. Ionogenic surfactants can be anion-active, cationic and amphoteric [23].

At concentrations exceeding a certain critical concentration, which is called the critical concentration of micelle formation (CMC), solutions of such surfactants acquire a colloidal character due to the formation of associated molecules (micelles). Therefore, colloidal surfactant solutions are also called micellar or associative solutions [25].

The critical concentration of micelle formation is a quantitative characteristic of micellar surfactant solutions. This definition is based on the study of various properties of these solutions: electrical conductivity, surface tension, osmotic pressure, which change during the formation of micelles.

The critical concentration of micelle formation depends on:

1. Depending on the structure and length of the hydrocarbon radical (by increasing the hydrocarbon radical, the value of the critical concentration of micelle formation decreases);
2. The nature of the polar group;
3. The presence of electrolytes in the solution;
4. Temperatures (with a decrease in temperature, the value of the critical concentration of micelle formation also decreases).

The process of micelle formation is characterized by a spontaneous decrease in Gibbs energy.It is also important that the process of micelle formation is reversible.

Micelles are aggregates of surfactants (surfactants) in a colloidal solution (ash), consisting of a large number of amphiphilic molecules. A surfactant solution in which micelles are in equilibrium with single unassociated molecules - monomers - is called a micellar solution [49].

Surfactants that can accumulate on the contact surface of two bodies or two thermodynamic phases (called the phase interface), and cause a decrease in the surface tension of the substances forming these phases [32].

On the interfacial surface, surfactants form a layer of increased concentration — an adsorption layer [33].

Many substances exhibit surface activity under certain conditions, but only those substances are usually called surface-active, the presence of which in solutions at very low concentrations (tenths and hundredths of %) leads to a sharp decrease in the surface tension of the substance of these solutions [26].

Such substances have an amphiphilic structure of molecules. That is, the micellar water molecule has two polarities, a hydrophilic head and a hydrophobic tail, which determines its mechanism of action during root canal irrigation [29].

Upon contact with the oily solution, the hydrophobic tail changes the polarity, thereby capturing the oily solution inside the sphere [31, 42].

When measuring the surface tension coefficient of micellar water, sodium hypochlorite, water and grapefruit oil in the study of Khabadze Z. S., Ismailova F. R. "Optimization of repeated endodontic treatment", it was concluded that micellar water has a higher leaching ability of material residues from dentine tubules compared with sodium hypochlorite [18, 40].

However, sodium hypochlorite also has a bactericidal effect, dissolves organic substances of the lubricated layer, pulp residues and microbial film, which is due to the dissociation of sodium salt ions of hypochlorous acid and the formation of free chlorine [34].

While other antimicrobial agents damage cell membranes or only coagulate proteins, causing bacterial cells to lose metabolic functions, hypochlorite, when in contact with tissue proteins, quickly disintegrates, releasing atomic chlorine, which, when combined with amino groups, forms chloramine — a well-known disinfectant. As a result of chemical reactions occurring with proteins, peptide bonds are broken, proteins are dissolved, and not coagulated. The chloramine formed as a result of the dissolution of tissue proteins disinfects the root canal dentin already freed from organic matter. The contents of the lateral tubules or apical delta, which cannot be processed instrumentally, are dissolved, which then allows for effective disinfection and sealing of the root canal.

By itself, sodium hypochlorite does not dissolve the lubricated layer, but only affects its organic part. Its complete removal is possible only after subsequent irrigation with citric acid or EDTA [30].

Sodium hypochlorite in endodontics performs the functions of an antiseptic, a solvent of necrotic tissues, reduces friction when working in the channel and reduces the likelihood of tool jamming.

A significant disadvantage of sodium hypochlorite should be considered its toxic effect. One of the acute conditions caused by the use of this substance should be considered a hypochlorite accident [2]. The substance goes beyond the canal, beyond the tip of the root, which causes acute pain in the patient and swelling of the tissues [35].

In endodontics, solution concentrations from 0.5 to 5.25% are used. For safety reasons, when processing the apical third of the root canal, it is recommended to use a 0.5-1.5% solution, when working in the middle part of the canal − 2.5-3%, in the tooth cavity and crown third for a better antibacterial effect − 5% [33]. Concentrated solutions of hypochlorite are rationally used mainly at the initial stage of chemical and instrumental treatment of root canals to dissolve organic tissue residues.

With the further passage of channels for their disinfection and washing out of dentine sawdust, it is sufficient to use low-concentrated, but warm solutions of hypochlorite, since an increase in the temperature of the solution leads to an increase in its activity and antimicrobial action.

Micellar water has minimal toxicity and is harmless when used not only in root canals, but also on the skin, which is why it has found application in dermato-cosmetology [36]. But it does not have bactericidal properties, which reduces the effectiveness of drug treatment [50].

Like any surfactant, micellar water actively forms a foam [37]. The liquid turned into foam dramatically increases the effective contact area of the active substances with the cleaning surface [45].

CONCLUSION

1. Micellar water is a promising tool for irrigation of root canals in the process of repeated endodontic treatment [38].
2. The amphiphilic structure of the micelles of the colloidal solution helps to reduce the surface tension of the oil solvent, its dissolution and leaching from the root canals [41].
3. This irrigant has minimal toxicity and is completely harmless to both the patient and the dentist [43]. However, the absence of a bactericidal effect significantly reduces the quality of drug treatment [47].
4. Therefore, further research should be directed to the optimization of this irrigation protocol, the introduction of this method into practice [44].

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