

Comparative Evaluation of Tooth Root Channel System Damage during Pre-obturative Endodontic Processing by Physical Methods

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Abstract

Aim: The authors studied the effect of diode laser radiation and ultraviolet irradiation of the yellow spectrum on the structure of the root dentin during the pre-obturative sanitation/treatment of the root canal system using scanning electron microscopy. **Materials and Methods:** The studies were carried out *in vitro* on the samples of removed teeth (roots) with fibrotic changes in periodontium that had not previously undergone endodontic treatment. **Results:** The results of the experimental study made it possible to reveal the structural damages of solid tissues in the system of root canals during the treatment with a diode laser and the structural preservation under the action of ultraviolet irradiation. **Conclusions:** Thus, the physical methods of root canal sterilization at endodontic tooth treatment have a significant advantage over traditional drug processing. Moreover, irradiation with ultraviolet is a gentler method than the treatment with a diode laser.

Key words: Endodontic treatment, laser radiation, scanning electron microscopy, the damages of the root canal hard tissues, UVC irradiation

INTRODUCTION

The main causes of tooth pain are the complicated forms of caries. According to different authors their prevalence is about 60.83% at least. Half of them are the teeth that have undergone endodontic treatment. Up to 68% of cases of acute inflammatory processes in the maxillofacial region are the result of poor-quality endodontic intervention.^[1-3]

Despite the improvement of material and technical support, the introduction of modern methods of instrumental and drug treatment, and dense root canal obturation, it is not always possible to achieve good results in endodontics. An important link of endodontic treatment is a qualitative and an effective antimicrobial treatment of root canals. Clinical observations in modern endodontics have shown the advantages and the efficacy of the combined

use of instrumental and drug treatment in combination with physical methods.

The combination of instrumental and drug treatment consists in the preparation of a root canal using gels or EDTA solutions and the irrigation of 3–5% sodium hypochlorite solutions. EDTA forms a compound with calcium dentine, dissolving its inorganic base, thereby facilitating preparation. Sodium hypochlorite dissolves the organic part of the dentin, the remains of the pulp, causing the death of bacteria in a root canal.

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By physical methods, we mean acoustic sanitation, an intracanal treatment with ozone, vacuum, and the irradiation with a diode laser. Moreover, the latter method has become widespread due to its availability, efficiency, and easy use.

Due to thin and flexible light guides, a diode laser is an excellent tool for root canal sterilization. Laser radiation has a powerful sterilizing and anti-inflammatory effect, as well as the effect of biostimulation; dental lasers are an effective and a sparing means for endodontic treatment. The treatment consists in laser therapy of an apical focus of inflammation, the laser sterilization of infected channels with subsequent sealing.

Despite the existence of a wide choice of disinfection methods, in practice, chronic inflammation in the periodontium is developed often after the treatment of pulpitis and apical periodontitis due to the deposition of infection in the dentinal root system.^[4-7] This suggests the need to search for new methods or to study the advantages and the disadvantages of known methods. In this regard, we decided to study in more detail the results of diode laser irradiation effect on the root dentine, as one of the methods widely used in dentistry, and the method of ultraviolet irradiation of the yellow spectrum, as the method suggested by our team.

Objective

The objective of this study was to study the condition of the hard tissues of the root canal system experimentally in the process of pre-obturbative treatment with diode laser radiation and ultraviolet irradiation of the yellow spectrum using scanning electron microscopy (SEM) and compare their effectiveness.

MATERIALS AND METHODS

An experimental study *in vitro* was performed on 45 samples of removed teeth (roots) with the diagnosis of chronic fibrous periodontitis, which had not been subjected previously to endodontic treatment. All examined teeth are divided into three groups, depending on the method of root canal treatment. Each group is represented by 15 teeth (roots). All root canals were treated according to the standard method: Odontopreparation, topography, and root canal length determination, the instrumental (mechanical) treatment using the “crown down” technique with the formation of an apical stop and taper. Instrumental and drug treatment of the root canal system were carried out according to a conventional technique using 17% EDTA and 3% sodium hypochlorite (NaOCl) with ultrasound activation. Then, the channels were washed with distilled water and dried by adsorbers.^[8]

In the first group, root canal treatment by physical methods was not performed but was limited only to instrumental

and medicinal treatment according to the above-mentioned method.

In the second group, the root canals were further treated with SIROLaser diode laser by Sirona (Germany) with a wavelength of 980 nm for 20 s.

In the third group, the root canals were additionally treated with a prototype device for disinfection and sterilization of the tooth root canal system radiating UVC irradiation with the wavelength of 255 ± 2 nm for 20 s.^[9,10]

Further, chips (thin sections) of the studied groups were prepared from all teeth to study in an SEM using the standard procedure [Figure 1].^[10] The photographs of the root dentin of the middle and apical third of the root were analyzed after a standard medical treatment with sodium hypochlorite 3%, the treatment with a diode laser and ultraviolet with the increase up to 30,000 times. The structure of the root dentin was significantly different, on the basis of which the results of the study are based.

RESULTS AND DISCUSSION

Root dentin is the indicator of the tooth pulp and periodontal tissue inflammation. Chronic inflammation leaves persistent changes in its structure and *vice versa*, the changes that have arisen in the process of endodontic tooth treatment can contribute to the development of the inflammatory process in periodontium.

The results of the root dentin study in the SEM were significantly different in the corresponding groups diagnostically, which was reflected in the scanning electronograms [Table 1].

When root canals were treated by the traditional method (Group I), it was found that a modified detritus layer and



Figure 1: Electronic scanning microscope

Table 1: The distribution of complications that occurred during pre-obturative treatment by groups

The distribution of complications	1 st group (%)	2 nd group (%)	3 rd group (%)
The presence of a modified layer of detritus and the foci of microbes	53±0.57	20±0.83	20±0.83
The presence of microcracks of the root dentin	-	60±0.64	-
The foci of dystrophic calcification	40±0.49	40±0.49	40±0.49

microbe foci were detected in eight cases (out of 15). A large number of sawdust, clumpy inclusions, which close the access to the dentin tubules were detected and presented in [Figure 2a and b]. Dentinal sawdust forms detritus in combination with reagents. Detritus is granular masses arising from the decay of necrotic tooth tissues; it is the source of infection, as it contains the remains of infected pulp tissues, bacteria, and toxic substances that can cause inflammatory and destructive changes in the periodontium in the future.

Thus, more than half of the teeth treated from complicated caries using the traditional method of drug treatment can be accompanied by inflammatory complications in periodontal tissues.

On microscopic photographs of tooth root clefts, the channels of which were treated with a laser (Group II) and ultraviolet (Group III), it was established that the modified detritus layer and microbial foci were detected in three cases (out of 15) in each group, and the dentinal tubules were fully and widely opened.

Thus, we can speak of physical method application superiority for root canal sterilization over the traditional method of drug treatment more than twice ($53\% \pm 0.57$ complications with the traditional method, as compared with $20\% \pm 0.83$ complications during the application of physical methods).

Besides, when the canal was treated with a laser [Figure 3a and b], the sites of dentinal tubule damage were revealed - in the form of microcracks in nine cases (out of 15), which was not noted in the tooth sections treated with the traditional method and ultraviolet [Figure 4a and b].

The microcracks of dentin with a qualitative sterilization of a root canal are filled with obturative material and do not lead to further complications. However, in combination with a modified detritus layer and microbe foci, they contribute to the accumulation and the spread of pathological microflora, which promotes the occurrence of inflammation in periapical tissues. All these confirm the advantages of ultraviolet irradiation method application for a root canal sterilization during endodontic tooth treatment.

In all study groups, the foci of dystrophic calcification were diagnosed equally in six cases (out of 15), which is the result of a persistent chronic inflammation. This may indicate the lack of above-mentioned methods effectiveness.

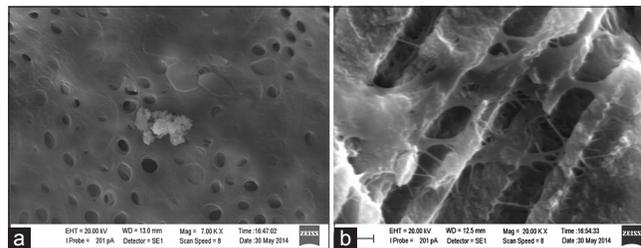


Figure 2: Electronic microphotographs of dentin processed by traditional method. (a) Middle third of the root, (b) apical third of the root

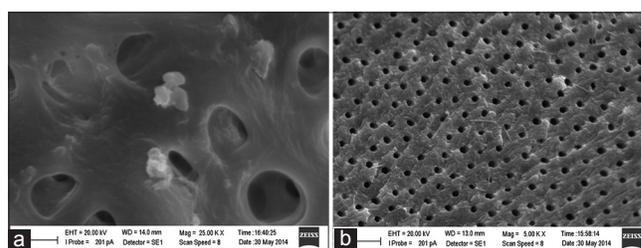


Figure 3: Electronic microphotographs of dentine treated with a laser. (a) Middle third of the root, (b) apical third of the root

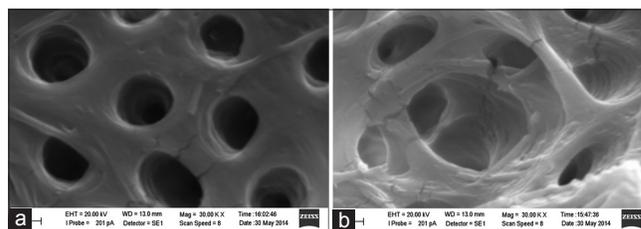


Figure 4: Electronic microphotographs of dentine treated with ultraviolet. (a) Middle third of the root, (b) apical third of the root

Summary

The analysis of laboratory study results made it possible to reveal the structural damages of root canal hard tissues in the form of microcracks arising from the exposure to a diode laser, which certainly speaks of the traumatic nature of pre-obturative treatment.

The structural preservation of tooth root canal hard tissues at the stage of pre-obturation is an important criterion for successful endodontic treatment.

The absence of the root canal wall integrity can lead to the complications in different periods at the stages of dental rehabilitation.

Ultraviolet irradiation treatment is a gentler method in positive antimicrobial therapy result achievement, which allows us to talk about this physical effect as a method of choice.

However, the presence of foci of dystrophic calcification is the manifestation of a “persistent” chronic inflammatory process in the root canal system of a tooth and does not depend on the method of hard tooth tissue processing.

CONCLUSIONS

Thus, the physical methods of root canal sterilization at endodontic tooth treatment have a significant advantage over traditional drug processing. Moreover, irradiation with ultraviolet is a gentler method than the treatment with a diode laser. However, none of the above-mentioned methods eliminates all signs of chronic inflammation; therefore, the search for new ways of atraumatic pre-obturative sanitation of the root canal system during the endodontic treatment of complicated forms of caries by the means of physical influence factors remains topical.

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