



Research paper

Efficacy of minimally invasive therapy and laser therapy in the comprehensive treatment of endoperiodontal lesions

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ABSTRACT

Introduction: A strategy for comprehensive treatment of endoperiodontal lesions is discussed, depending on the severity of pathology in the endodontium and periodontium associated with mild chronic generalized periodontitis.

Aim: The purpose of the study was to evaluate the efficiency of minimally invasive therapy and laser therapy in the comprehensive treatment of endoperiodontal lesions associated with chronic generalized periodontitis.

Material and methods: Sixty patients with apical periodontitis were examined and received periodontal treatment using minimally invasive therapy and laser therapy in combination with endodontic stages of treatment.

Results and discussion: Pain when biting down, sometimes aggravated with solid food, was reported for several days in 38% of cases in the control group. The patients of the study group did not report painful sensations; in 20% of cases, inconveniences only occurred with solid food during the first days.

Conclusions: The study showed that in all clinical cases selected for this article, a comprehensive treatment including minimally invasive therapy and laser therapy was effective with both endodontic and periodontal sparing treatment.

1. INTRODUCTION

The issues of diagnosis and treatment of apical periodontitis in patients with inflammatory periodontal diseases are intractable in current dentistry. A complex of pathological, morphological and functional symptoms of the periodontal and endodontic lesions is called endoperiodontal syndrome. Endoperiodontal syndrome manifests itself as an inflammation in the periodontium, which anatomically consists of two sections: apical and marginal. However, the marginal periodontium is an element of the dental periodontium, while the apical periodontium is an element of the endodontium. Such anatomical and physiological proximity of these formations causes simultaneous damage to the periodontium and endodontium during periodontal inflammation, which requires a comprehensive treatment of this pathology.¹ According to the authors, the endodontium includes two dental tissues: dentin and pulp, which constitute a structural and functional unity. These tissues have a huge mutual influence – the pulp (in particular) nourishes the dentin, and the dentin forms a protective barrier for the pulp. They both develop from the papillary tissue (*papilladentis*).² However, in clinical practice, this structural-functional complex is often viewed as two separate tissues, rather than one. Adequate knowledge of the structure, function and defense mechanisms of the endodontium contributes to successful treatment outcomes.

From the etiological point of view, endoperiodontal lesions develop following either pulp or periodontal pathology. In the first case, the pathology is associated with a long-standing fistulous passage in the area of the transitional fold and the formation of a periodontal pocket with the epithelial lining. This requires mandatory endodontic treatment. At the same time, at this stage, the treatment of the pathological focus only by endodontic methods is impossible. It is necessary to carry out periodontal treatment, which results in the elimination of the defect due to scarring of the gingival pocket. In the second case, the endoperiodontal lesion develops due to a periodontal pathology, in which the periodontal pocket extends towards the root apex and causes retrograde pulpitis. Studies by Jivoinovici et al. show that damage to the pulp tissue usually begins in the coronal pulp. Its poor management or untimely detection determine a gradual involvement of the entire endodontic space in its evolution, opening the way for its expansion into the surrounding tooth tissues and into the marginal apical tissue.³

To date, antibiotic injections in the oral cavity are still prescribed in chronic generalized periodontitis (CGP).⁴ This method of treatment contradicts all principles of antibiotic therapy, does not take into account the anatomical and physiological features of the structure of soft tissues in this area, promotes the formation of stable microflora and the development of severe complications, destabilizes the inflammatory process in the periodontium, as well as misinforms a doctor and a patient about the expected outcome of the disease. It is of general knowledge that a discharge of toxic products from the necrotic pulp into the periapical region results in its inflammation. As the blood vessels

dilate and fluid builds up, pressure in the periapical region may increase. The accumulation of fluid often becomes simply unbearable and severe pain, if not relieved, can reach a level where even strong analgesics will not help. However, residual pulp removal may not be sufficient, in which case a direct access to the apex through the bone is the only alternative. This operation is quite traumatic and rather complicated in terms of technical performance, therefore, the search for new methods of treatment to avoid surgical intervention is urgent.^{5,6} Lack of information among dentists about the treatment options for endoperiodontal lesions is the main reason for the extraction of such teeth. A simultaneous elimination of pathogens from both the periodontal pocket and root canals is a key factor for effective treatment. The periodontal condition is the main factor for the prognosis for a tooth with pathological endoperiodontal lesions, therefore, the treatment of pathological endoperiodontal lesions should consist of two stages: elimination of the infection and regeneration of the structures supporting the tooth.

Based on the foregoing, there is a need to develop a strategy for the treatment of endoperiodontal syndrome associated with CGP to avoid surgical intervention, which determined the purpose and objectives of this study. The main research objectives are:

- to examine patients with apical periodontitis associated with mild CGP,
- to determine the effect of MIT and laser therapy on patients,
- to evaluate the clinical efficiency of the laser therapy,
- to study the effect of comprehensive therapy on the parameters of local immunity of the oral cavity.

2. AIM

The purpose of the study was to evaluate the efficiency of minimally invasive therapy and laser therapy in the comprehensive treatment of endoperiodontal lesions associated with CGP.

3. MATERIAL AND METHODS

Using a random sampling technique, we examined 60 patients (33 men and 27 women aged 25 to 55 years) with apical periodontitis associated with mild CGP. In the control group of patients (25 people), endodontic and periodontal treatment was performed according to the clinical protocol of the Ministry of Health of the Republic of Kazakhstan – 2015. The study group of patients (35 people) underwent endodontic and periodontal treatment in accordance with the clinical protocol of the Ministry of Health of the Republic of Kazakhstan – 2015 and additional minimally invasive therapy (MIT) using the Vector (Germany) device and laser therapy. The Vector therapy principle is a gentle method based on the use of ultrasound and calcium hydroxide suspension, based on the conservative principle and vibration-free, minimally invasive Vector System instruments. In this case, the goal of periodontal treatment is the forma-

tion of the sub-gingival root surface and its supportive treatment with process stabilization at the subsequent stages. It is almost impossible to completely eliminate sub-gingival or supra-gingival plaque. The main task is to achieve homeostasis, or balance, between the resident bacteria and the macroorganism. Non-pathogenic microorganisms may be considered beneficial because they often keep pathogenic bacteria under control. The first step to achieve homeostasis is the mechanical destruction of the close community of the microorganisms, which form a biofilm in the periodontal pocket, and their subsequent elimination. The body's defense systems also act against the biofilm. The therapy is aimed at creating a healthy root surface, focusing on the 'one stage full-mouth disinfection' principle.⁷

Laser therapy was performed with the Optodan laser semiconductor physiotherapeutic device with a frequency of 1 kHz, exposure – 5 minutes. The course of treatment included 7 sessions. The mechanism of the therapeutic action of laser therapy is as follows: a pronounced anti-inflammatory and analgesic effect, improvement of microcirculation, normalization of the permeability of the vascular walls and metabolic processes, an increase in the oxygen levels in the tissues, a significant acceleration of regeneration of the soft and bone tissues, stimulation of the immunological defense system, as well as a decrease in the pathogenicity of microflora.^{8–10} The evaluation of the clinical efficiency of the therapy was based on a comparison of the subjective data obtained from patient interviews, clinical study results, electroodontodiagnostics and computer visiography, carried out before and after treatment. During registration of the periodontal status before treatment, the rate and severity of inflammatory-destructive changes were assessed using the Russell's periodontal index. The hygienic state of the oral cavity was determined using the Greene and Vermillion simplified oral hygiene index (SOHI).

Immunological study results were used to objectively assess the state of the periodontal tissues. To assess the state of humoral immunity, lysozyme levels and secretory immunoglobulin A (sIgA) concentrations were assessed using radial immunodiffusion according to Mancini with the Immunospektr 32 standard sets manufactured by SPC MedBioSpektr (Russian Federation). The results were statistically processed on a computer using the Microsoft Excel 7.0. The arithmetic mean of the variation series (M), the mean square error (m) and the correlation coefficient between the two sets of data (r) were calculated. The significance of shifts and differences in the compared parameters were evaluated using the Student's t -test. The differences were considered significant if $P < 0.05$.

4. RESULTS AND DISCUSSION

In the course of the study, it was found that the patient's tolerance to MIT and laser therapy was very good. During the course of treatment, no side effects, allergic or phototoxic reactions were observed. The patients did not experience any unpleasant sensations either when using the Vector on the periodontal tissues or when using the laser therapy later.

Table 1. The SOHI parameters in the groups.

Group	Time point	SOHI, points
Control group	Before treatment	2.85 ± 0.06
	After treatment	1.1 ± 0.04*
Study group	Before treatment	2.7 ± 0.06
	After treatment	0.6 ± 0.01*°

Comments: * significant difference before and after treatment ($P < 0.05$); ° significant difference between the groups in the parameters after treatment ($P < 0.05$).

A clinical examination 7 days after treatment showed that the SOHI values were significantly lower in patients from the study group who underwent MIT and laser therapy, compared to the control group. As shown in Table 1, the comprehensive treatment contributed to a significant decrease in the SOHI by 0.2 points. Here we must take into account a personalized approach in each patient, since oral care, correct brushing technique, choice of personal oral hygiene products, implementation of hygiene procedures and home care procedures, balanced diet and elimination of bad habits, such as smoking, use of high-carbon foods, as well as factors that influenced the patient's quality of life, depend on the patient.

According to our results, the baseline Russell's periodontal index (PIs) showed a moderate periodontal pathology in both groups. Three months after treatment, the PIs in both groups approached the best results but a significant improvement was observed in the study group (Figure 1).

A repeated computer visiography 6 months after the comprehensive therapeutic measures showed a decrease in the focus of radiolucency in the apical part of the roots to 2.3 ± 0.2 mm, compared to a baseline value of 2.7 ± 0.2 mm, in the control group, and up to 2.2 ± 0.2 mm compared to a baseline value of 2.9 ± 0.2 mm, in the study group. The success of endodontic treatment depends on the knowledge of the topographic anatomy of the tooth cavity and root canals and the correct tactics of root canal preparation. According to the clinical protocol for endodontic treatment of apical periodontitis, it includes two important and mutually complementary stages – preparation and pharmacological treatment of the root canal.¹¹ The main task of root canal instrumental treatment is to reduce a degree of bacterial

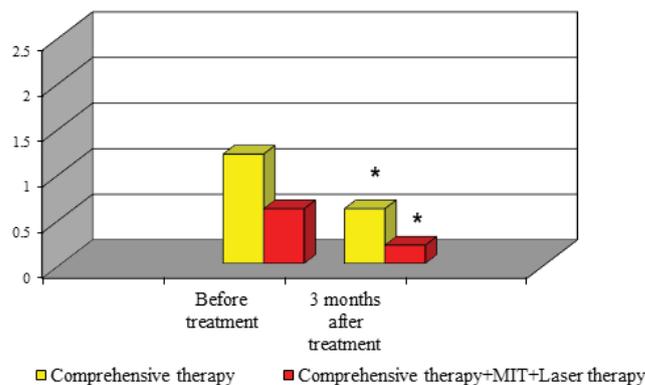


Figure 1. Treatment effects on the PIs. Comments: * significant difference between treatment parameters ($P < 0.05$).

contamination of the root canal. Antiseptic treatment of the root canal system is of particular importance. According to the opinion of the experts of the European Endodontic Society on the main quality parameters in endodontic treatment, the purpose of irrigation is as follows: to dissolve organic residues, to eliminate microflora, tissue fragments and dentinal sawdust and to lubricate the endodontic instrument.

A common and effective irrigation solution is sodium hypochlorite at a concentration of 0.5% to 5%. It has pronounced bactericidal effect; when organic residues dissolve, chloramine is formed, which causes irreversible enzymatic inactivation in bacteria.^{12,13} The use of the drugs containing 17% EDTA in combination with 3% sodium hypochlorite and 3% hydrogen peroxide provides a high degree of cleaning of the walls of the root canals from the smeared layer, which leaves pathogenic microorganisms in the dentinal tubules 'inaccessible'.^{14,15} Endodontic treatment may not always be completed immediately with permanent filling in one session. The reason for this is a complex anatomical structure of the root canal system, the presence of a periapical focus of bone tissue rarefaction, especially in endoperiodontal lesions, and destructive forms of periodontitis. To solve this problem, many authors propose to use a prolonged therapy with calcium hydroxide products.^{16,17} According to the 2019 study results by Ashurov et al.,¹⁸ in case of combined lesions of the periodontium and periapical tissues in patients with endoperiodontal pathologies, the use of calcium-containing drugs in recommended doses (from 1 to 3 months, 1000 mg/day) and antimicrobial and antioxidant agents significantly affect the rate of repair of the bone tissues both in the periapical foci of destruction and in the periodontal tissues. The prognosis and long-term efficiency of endodontic treatment depends on the effective obturation of the root canal, which is confirmed by control radiography of the tooth.^{18,19} The outcomes of endodontic treatment may depend on combined dental pathology, baseline severity of destructive processes and poorly performed endodontic treatment.²⁰ Among the dubious and unsatisfactory results of endodontic treatment, poorly performed treatment associated with the removal of filling masses outside the apical aperture was observed in 4 (33.3%) patients in the study group. In the remaining patients with good results of endodontic treatment, all interventions were performed to a good quality.

In wide clinical practice, periodontitis is commonly observed in the grinder teeth of the upper and lower jaw. This is often caused by local developmental factors such as poor oral hygiene, improper brushing technique, impaired articulation, etc. These local factors lead to chronicity of the foci of infection in the oral cavity, thereby impairing the immunological balance of the body.²¹ Periapical infection can support the growth of microbial pathogens in the root canals, penetrating into the periodontium through the apical aperture, lateral canals and dentinal tubules, resulting in further spread of inflammation in the periodontal tissue manifested by an increased formation of the granulation tissue and increased osteoclast activity. The accumulation of bacterial

Table 2. Effects of comprehensive therapy on the parameters of local immunity in the oral cavity.

Parameter	Time point	Control group	Study group
Lysozyme, $\mu\text{g/mL}$	before treatment	18.7 \pm 0.03	18.74 \pm 0.01
	3 months after treatment	14.7 \pm 0.03*	10.8 \pm 0.04*
sIgA, g/L	before treatment	0.48 \pm 0.06	0.43 \pm 0.08
	3 months after treatment	0.56 \pm 0.02*	0.64 \pm 0.04*

Comments: * significance of differences compared to baseline ($P < 0.05$).

cells leads to the formation of periodontal pathogenic toxins and the production of antibodies.^{22,23} In the world literature, there are many publications devoted to the studies of the impact of the pathological state of the periodontium on the local immunity of the oral cavity.²⁴ Considering the great importance of streptococcal microorganisms in periodontal diseases, we studied some parameters of local immunity.

As shown in Table 2, the initial state of local immunity in the groups was relatively equivalent. Three months after treatment, the sIgA levels increased by 16.6% in the control group and approached normal values in the study group. The levels of lysozyme in the control group decreased by 21.3%, compared to baseline, and decreased by 42.4% in the study group 3 months after treatment. Therefore, during the study, we observed changes in the immune homeostasis in this pathology; the mucosal immunity of the oral cavity functioned in a stress mode. After the comprehensive treatment, the local resistance parameters normalized. According to the results of the 2017 studies by Rangbulla et al. the biomarkers to determine sIgA levels, interleukin-1 β (IL-1 β) and matrix metalloproteinase-8 (MMP-8) were identified in the patients with moderate to severe CGP. The authors believe that biomarkers can facilitate screening, early diagnosis and treatment of periodontal diseases.²⁵

Patients with endoperiodontal pathologies associated with CGP require high-quality dental care, including systematic and continuous outpatient follow-up, as well as preventive and hygienic measures in cooperation with a dentist.

5. CONCLUSIONS

Minimally invasive therapy in periodontology can be used after the initial phase of treatment as an addition to professional hygiene measures and as an alternative to surgical interventions in mild disease, using a personalized approach, to treat the root surface and periodontal pockets of various depths at the stages of maintenance therapy. The comprehensive treatment including minimally invasive therapy and laser therapy should be considered as a therapy to prevent early tooth loss and articulation impairment, which result in a deterioration of the quality of life of patients, although more studies with a larger sampling sizes and longer follow-up periods are required.

Conflict of interest

None declared.

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