DOI 10.26724/2079-8334-2022-3-81-7-12
UDC 616.314.17-008.1-036.12-002-08

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CHOOSING THE OPTIMAL TREATMENT METHOD IN PATIENTS WITH APICAL PERIODONTITIS

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The article provides information on choosing the optimal treatment method in patients with apical periodontitis, taking into account the nature of the inflammatory changes in the periapical dental tissues. 120 patients with different forms of apical periodontitis were examined and 3 groups were formed from them. “Closed” and “opened” treatment methods for apical periodontitis were used for the patients diagnosed with acute apical periodontitis and periapical abscess, and both therapeutic and surgical treatment methods were used for the patients with complications of apical periodontitis, i.e. with acute periostitis and osteomyelitis. In patients of the group where the “closed” treatment method of apical periodontitis was used, the periapical index decreased from 2.77±0.136 to 1.20±0.114 points and from 2.50±0.133 to 1.57±0.114 points; in patients of the group where the “opened” treatment method of apical periodontitis was used, it decreased from 2.55±0.185 to 1.80±0.117 points. In patients with complications of apical periodontitis, compared to the previous groups, the periapical index decreased slightly and amounted to 2.06±0.117 points. Thus, research has shown that more reliable treatment methods were as follows: “closed” and “opened” treatment methods of apical periodontitis during the development of acute apical periodontitis and periapical abscess, and conservative and surgical intervention in the treatment of both acute periostitis and acute osteomyelitis.

Key words: acute apical periodontitis, periapical abscess, acute periostitis, focus of periapical destruction, periapical index, treatment of acute apical periodontitis, redness of mucous membrane.

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ВИБІР ОПТИМАЛЬНОГО МЕТОДУ ЛІКУВАННЯ ХВОРИХ З ВЕРХІВКОВИМ ПЕРІОДОНТИТОМ

В статті представлена інформація про визначення оптимального методу лікування хворих з верхівковим періодонтитом в залежності від характеру запальних змін в періапікальних тканинах. З цією метою були обстежені 120 хворих з різними формами верхівкового періодонтиту і з них були сформовані 3 групи. У хворих з діагнозом гострий верхівковий періодонтит і періапікальний абсцес застосовували «закритий» і «відкритий» методи лікування періодонтиту, а у хворих з ускладненнями періодонтиту, тобто з гострим періоститом і остеомієлітом застосовували терапевтичні та хірургічні методи лікування. У пацієнтів групи, де застосовувався «закритий» метод лікування верхівкового періодонтиту, періапікальний індекс знизився з 2,77±0,136 до 1,20±0,114 бала та з 2,50±0,133 до 1,57±0,114 бала; у хворих групи, де застосовувався «відкритий» метод лікування верхівкового періодонтиту, цей індекс знизився з 2,55±0,185 до 1,80±0,117 бала. У хворих з ускладненнями верхівкового періодонтиту порівняно з попередніми групами періапікальний індекс дещо знизився і становив 2,06±0,117 бала. Так, дослідження показало, що більш надійними методами лікування є: «закритий» та «відкритий» методи лікування при розвитку гострого верхівкового періодонтиту та періапікального абсцесу, а також консервативне та оперативне втручання при лікуванні як гострого періоститу, так і гострого остеомієліту.

Ключові слова: гострий верхівковий періодонтит, періапікальний абсцес, періапікальний осередок деструкції, періапікальний індекс, лікування гострого періодонтиту, гіперемія слизової оболонки.

In recent medical literature, there is information about the widespread prevalence of pulpitis and apical periodontitis, complications of caries among the population [1, 12], errors in the diagnosis of these diseases, and the presence of complications after their treatment [6, 13]. Despite the fact that dentists have modern equipment, devices and medications, and the considerable development of endodontic treatment, unsolved problems in this field remain today [9, 10]. In the research of blighty and foreign scientists, information about the low-quality level of endodontic treatment is given [3, 11]. A group of scientists associate the failure of endodontic treatment with incomplete sealing or oversealing of canals [2, 4]. Other specialists note that the composition of temporary and permanent sealing materials for the obturation of the canals plays a significant role in the assessment of the quality of endodontic treatment [5, 9], while the third one explains the reason for insufficient results during endodontic treatment with the quality lack of chemical-mechanical treatment of the dental root-canal system [4, 8]. In a number of scientific researches carried out in our republic, information is given about the improvement of the quality of endodontic treatment [3, 5]. By testing different treatment schemes in the groups of patients with dental periapical destruction, the author studied the reduction of periapical destruction according to the (PAI) index and

achieved positive results in this direction [3]. Kh.B. Nasirova in order to carry out successful endodontic treatment and restore periapical tissues in patients used the propolis-based preparation [5].

Treatment of teeth injured by apical periodontitis with or without periapical destruction is one of the important issues of endodontics. Thus, the results of the performed endodontic treatment depend not only on the qualification of the dentists, but also on the individual response of the organism to the performed treatment, the ability of the dentist to carry out medical manipulations correctly, and the nature of the changes in the periapical tissues (microorganisms, apical granuloma, cyst). All this shows that both qualities of endodontic treatment and the prevention of complications after the treatment of apical periodontitis are urgent issues of endodontics.

The purpose of the study was to determine the optimal treatment method depending on the nature of inflammatory changes in periapical tissues in patients with apical periodontitis.

Materials and methods. Taking into account the above-mentioned, in order to improve the treatment quality of apical periodontitis and prevent post-treatment complications, we have examined 120 patients aged from 12 to 60 years with different forms of apical periodontitis (acute apical periodontitis, periapical abscess with and without fistula path, advanced complications of apical periodontitis such as periostitis and osteomyelitis). Patients were divided into 3 groups, taking into account the development phases of acute apical periodontitis.

The groups were treated with different methods. “Closed” treatment method of apical periodontitis was used in patients of group I consisting of 35 people with serous and purulent phases of acute apical periodontitis. Patients of this group had fewer complaints at the beginning of the disease development, and as a result of the increasing process in the periodontium, continuous, intense pain in the teeth, acute pain on palpation and percussion, redness in the affected dental area, swelling, mobility and elongation sensation in the teeth were observed.

During the treatment, after removal of the internal content of the canals and their antiseptic and mechanical treatment, they were sealed with calcium hydroxide paste and temporarily closed for 2 weeks. In case of no complaints from the patients at the next visit, the canals were permanently sealed.

Group II consisted of 50 patients diagnosed with exudative inflammation of acute apical periodontitis and periapical abscess were divided into 2 subgroups: The patients of the 1st subgroup consisted of 30 people who were treated by the “closed” method, and the patients of the 2nd subgroup consisted of 20 people were treated by the “opened" method. In the 1st subgroup, as in group I, the treatment was carried out with the “closed” method.

In these patients, the constant aching pain in the area of the causal tooth gets a diffuse and attack-like character. Patients felt acute pain on percussion and biting. During examination and palpation, redness, swelling, infiltrating in the mucous membrane of the gingiva and mucosa-alveolar fold, sometimes deformation of the alveolar bone wall, enlargement and pain of the lymph nodes were noted, and destructive changes in the radicular apex and in the apical periodontium and bone tissue were radiologically observed.

During the treatment with the “opened” method, at the 1st visit of the patients, after removal of the intra-canal content and processing of the canals, they were kept open for 1–3 days. After acute inflammation in the periapical tissues had subsided, they were sealed with calcium hydroxide paste. In the end, after elimination of the periapical destruction center and if the patients had no complaints, the canals were sealed by the lateral condensation method. Conservative and surgical treatment methods were used in group III consisting of 35 patients with exacerbated phases of acute apical periodontitis (acute periostitis, acute osteomyelitis).

In these patients, collateral inflammation (edema) of peri-jaw tissues in the area of the causal tooth, diffuse infiltration of the mucosa-alveolar fold with the formation of subperiosteal abscess were characteristic of periostitis, and inflammatory changes (edema) of the soft tissues located on both sides of the alveolar ridge and the jaw body were characteristic for osteomyelitis.

“Closed” and “opened” treatment methods were applied in cases where the canals were well passed. If the mechanical and medical treatment of difficult-to-pass canals was not possible, tooth-saving surgical operations (incision in the gingiva in the region of the dental root projection, resection and amputation of the dental root) had been performed. In acute odontogenic processes, the tooth was extracted if it did not respond to treatment. The results of the treatment carried out in all groups were studied by collecting history from the patients, clinical research methods (inspection, probing, percussion, palpation) and radiological research methods. The detection of changes in periapical tissues and the state of periapical tissues during endodontic treatment were evaluated according to the modified PAI (A.M. Solovyova, 1999) on the basis of dental radiographs taken before, during, and after treatment [8].

Non-parametric U-test (Wilcoxon-Mann-Whitney), Fisher's honest test and parametric Student's t-test were used as methods to evaluate the differences between indicators in the statistical processing of data. The difference between groups was considered statistically significant at $p<0.05$. Statistical processing of the obtained data was carried out on a personal computer using the Excel table editor and Statistica 7.0 package.

Results of the study and their discussion. A comparative analysis of the results of the treatment-prophylactic measures applied to the patients situated under our observation for 2 years, demonstrated that the "closed" treatment method of apical periodontitis was applied in patients of group I with serous and purulent phases of acute apical periodontitis. In patients of this group radiological changes in periodontal tissues were detected before the treatment. Changes in periapical tissues were noted in 82.9±6.37 % ($p\leq0.05$) patients after 6 months as a result of the treatment measures. Changes in periapical tissues were observed in 45.7±8.42 % ($p\leq0.001$) of patients after 1 year and 11.4±5.38 % ($p\leq0.001$) after 2 years of treatment (table 1).

Table 1

The number of teeth with periapical destruction in patients with apical periodontitis before and after treatment

Groups	Before treatment	Terms after treatment		
		6 months	12 months	24 months
Group I n = 35 “closed” treatment method	35 100 %	29*** 82.9±6.37 %	16* 45.7±8.42 %	4* 11.4±5.38 %
1st subgroup of Group II n=30 “closed” treatment method	28 93.3±4.55 %	26 86.7±6.21 %	19*** 63.3±8.80 %	13* 43.3±9.05 %
2nd subgroup of Group II n=20 “opened” treatment method	19 95.0±4.87 %	17 85.0±7.98 %	14 70.0±10.25 %	8* 40.0±10.95 %
Group III n=35 “opened” and “closed” treatment methods	34 97.1±2.82 %	33 94.3±3.92 %	29 82.9±6.37 %	21* 60.0±8.28 %

Note: statistical significance of the difference compared to pre-treatment status – $p<0.001$, ** – $p<0.01$, ***– $p<0.05$

It should be noted that the results obtained 6 months, 1 year and 2 years after the treatment were statistically honest compared to the pre-treatment indicator. The mentioned indicators are much lower than the indicators of the II and III groups in the same periods. The more effective treatment in this group was also confirmed by the PAI index, which reflects the change in the focus of destruction in periapical tissues. Thus, PAI index in group I before treatment was 2.77±0.136, 6 months, 1 year and 2 years after treatment. Respectively it was 2.71±0.133, 1.83±0.77 ($p\leq0.001$) and 1.20±0.114 ($p\leq0.001$) points (table 2). The results obtained in the mentioned periods are statistically significant. In 1st subgroup of group II, the destruction focus of periodontal tissues was detected in 93.3±4.55 % of patients before treatment. In this group, 6 months after the treatment, in 86.7±6.21 % of patients a destruction focus was observed.

Table 2

Average values of indicators obtained according to A.M.Solovyova's modified PAI index in dynamics in patients with apical periodontitis

Groups	Before treatment	Terms after treatment		
		6 months	12 months	24 months
Group I n = 35	2.77±0.136	2.71 ±0.133	1.83±0.077*	1.20±0.114*
1st subgroup of Group II n=30	2.50±0.133	2.67±0.130	2.03±0.102**	1.57±0.114*
2nd subgroup of Group II n=20	2.55±0.185	2.60±0.169	2.25±0.123	1.80±0.117**
Group III n=35	2.57±0.125	2.83±0.119	2.40±0.102	2.06±0.117**

Note: statistical significance of the difference compared to pre-treatment status *–$p\leq0.001$, **–$p\leq0.01$, ***–$p\leq0.05$

The mentioned sign decreasing was observed in 63.3±8.80 % ($p\leq0.05$) and 43.3±9.05 % ($p\leq0.001$) of patients after 1 year and 2 years, respectively. These indicators are more than the indicators of group I, and much less than the analogous indicators of group III.

In the patients of this group the PAI index, which reflects changes in the periapical inflammatory focus during the treatment process in the dynamics, was as follows: PAI index in this subgroup before treatment was 2.50±0.133 points, 6 months, 1 year and 2 years after treatment it was 2.67±0.130, 2.03±0.102 ($p\leq0.01$) and 1.57±0.114 ($p\leq0.001$) points respectively, thus, these indicators were slightly higher compared to the same periods of the group I described above, and lower than the analogous indicators of the 2nd subgroup of the group II and the group III. Despite the fact that the 1st and 2nd subgroups of group II, which were under our observation for 2 years, were composed of the same patients, that is,

patients with purulent inflammation of acute apical periodontitis and periapical abscess, different treatment methods were performed in the 1st and 2nd subgroups.

In the 2nd subgroup (20 people), the "opened" treatment method of apical periodontitis was applied. In the 1st subgroup consisting of 30 people, the "closed" treatment method of apical periodontitis was applied. Also, the same"closed" treatment method for apical periodontitis was applied to the patients of group I and 1st subgroup of group II.

Periapical destruction was detected in 95.0±4.87 % of patients with acute apical purulent periodontitis and periapical abscess (2nd subgroup of group II).

In this group, 6 months after the treatment, a periapical destruction center was identified in 85.0±7.98 % of patients.1 year and 2 years after the treatment, the indicated indicator was 70.0±10.24 % and 40.0±10.95 %, respectively. In this subgroup, the obtained result 2 years after treatment was statistically significant compared to the primary indicator. In the subgroup composed of 20 people with periapical abscess and exudative inflammatory phase of acute apical periodontitis (2nd subgroup of group II), the PAI index was 2.55±0.185 points before treatment, 2.60±0.169 points after 6 months of the treatment, and 12 months and 24 months after treatment it was 2.25±0.123 and 1.80±0.117 points, respectively. In the mentioned subgroup, the result of PAI index obtained 2 years after the treatment was statistically honest compared to the two indices before the treatment ($p \leq 0.001$).

In group III, in patients with complications of acute apical periodontitis (acute periostitis, acute osteomyelitis, etc.), the focus of destruction in periapical tissues was found in 97.1±2.82 % of patients before treatment. After 6 months of treatment, this index was 94.3±3.92 %. The specified indicator in this group was 82.9±6.37 % and 60.0±8.28 % after 12 months and 24 months, respectively. In this group, the result obtained 2 years after the treatment was statistically significantly different from the result obtained before the treatment.

In group III composed of 35 patients with the exacerbated phase of acute apical periodontitis, the indicators due to the modified periapical PAI index of A.M. Solovyova changed in the patients as follows: PAI was 2.57±0.125 points before treatment, 2.83±0.119 points after 6 months of treatment, and 2.40±0.102 and 2.06±1.117 points after 12 months and 24 months of treatment, respectively. This is much more than the indicators in the corresponding periods of the previous groups. The results of our research performed in treatment groups of patients with apical periodontitis for a period of 2 years showed that in group I (patients with serous and purulent phases of acute apical periodontitis) and 1st subgroup of group II (patients with exudative inflammation of acute apical periodontitis and periapical abscess) 6 months after treatment, positive radiological results were obtained according to growth indicators related to PAI index (2.71±0.133 and 2.67±0.130 points). In group III (patients with complicated phases of acute apical periodontitis), in contrast to the previous two groups, the initial positive radiological results were obtained 12 months after treatment and were 2.40±0.102 points.A.M. Solovyova's mean growth indices of periapical regeneration according to PAI index were 1.20±0.114 and 1.57±0.114 points in groups I and II after 2 years, respectively, which is less than the similar index of group III (2.06±0.177). These also show that the periapical bone tissue is more intensively restored in groups I and II. Thus, in the light phases of acute apical periodontitis, endodontic treatment with calcium-containing preparations shortens the regeneration period, preserves the tooth and quickly restores its function.

The results of various treatment measures carried out in research groups for a period of 2 years showed that the best results were obtained in group I (patients with acute apical serous and purulent periodontitis) and 1st subgroup of group II (patients with acute apical periodontitis and periapical abscess) where the "closed" treatment method of apical periodontitis was applied. This method of treatment was more successful in patients of group I . The positive results of the treatment in this group were confirmed by studied for 2 years oral hygienic OHI-S and Fyodorov-Volodkina indices and indicators which study the gingival mucosa (fig.1).

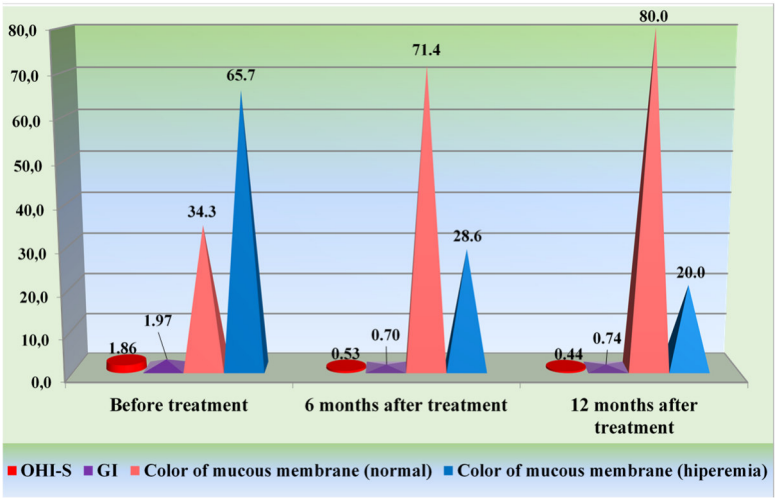

Fig.1. Changes in indicators of objective tests and clinical signs depending on observation periods in group I of patients with apical periodontitis

The results obtained 6 months, 1 year and 2 years after applying the "closed" treatment method of apical periodontitis in patients of group I were statistically honest compared to the pre-treatment indicators ($p \leq 0.001$). Endodontic treatment carried out in groups has resulted in success in most cases. However, in some cases, there were sensitivity, pain, discomfort, swelling, and complications in the treated teeth. In the group I where the "closed" treatment method of apical periodontitis was applied, the high effect of the treatment was related to the quick removal of the intra-canal contents (necrotized coronal and root pulp, putrid substances), medical treatment and instrumentation of the canals, introduction of the medications that neutralize toxic substances inside the canal, retention of antibacterial and anti-inflammatory medications inside the canals.

The relatively low effectiveness of the treatment carried out in the 1st subgroup of the group II (30 patients with purulent apical periodontitis and periapical abscess) compared to the group I is due to the fact that the inflammation in the teeth with acute apical periodontitis is more spread in the periapical tissues, the serous exudate turns into the purulent exudate, and the formation of large destruction foci. The indicators of the oral hygienic condition and the gingival mucosa confirm the positive orientation of the treatment carried out in this subgroup (fig. 2).

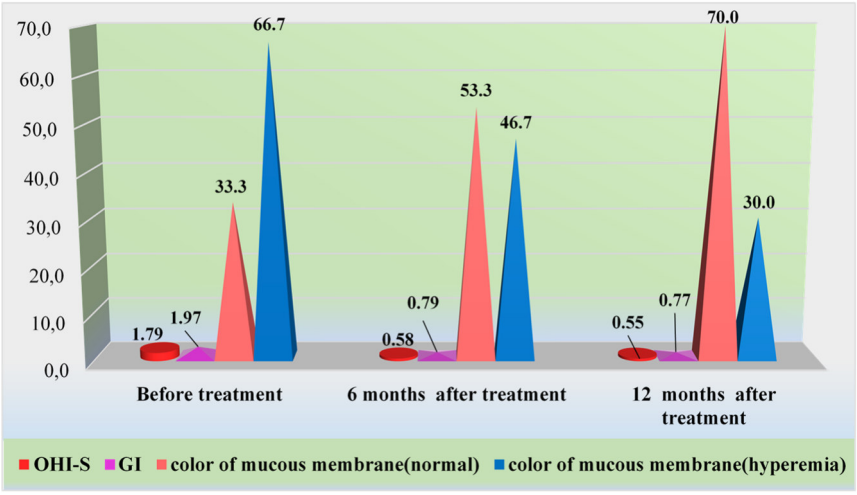

Fig. 2. Changes in indicators of objective tests and clinical signs depending on observation periods in patients of subgroup 1 of group II with apical periodontitis.

The "opened" treatment method of apical periodontitis used in patients of the 2nd subgroup of group II (exudative inflammatory phase of acute apical periodontitis and periapical abscess) was less effective compared to the previous groups. This result is also confirmed by the obtained indices.

As we mentioned, in the 1st and 2nd subgroups (patients with acute purulent apical periodontitis and periapical abscess), which were composed of patients with the same disease state of group II, different treatment methods ("closed" and "opened" treatment methods of apical periodontitis, respectively) affected the results of treatment. It should be noted that the results obtained 1 year after in the 1st subgroup were statistically honest ($p \leq 0.001$) due to normal and inflammatory indicators of the mucous membrane, but the results obtained in the 2nd subgroup were not.

Keeping the canal "opened" within 1-3 days in the patients of the 2nd subgroup of group II, on the one hand, made it possible for purulent exudate to be discharged from the periapical tissues through the canal, but on the other hand, it caused contamination of the dental canal with secondary infection. This ultimately caused the inflammation to remain for a long time (pain on palpation and percussion).

"Closed" and "opened" treatment methods of apical periodontitis in patients of group III (acute periostitis, acute osteomyelitis, teeth with purulent root cysts) has failed in most of cases because the canals were difficult to pass, obturation, too large sizes of root cyst in the periapical region, and ineffective treatment measures taken due to their suppuration. The less effectiveness of treatment in the patients of this group is confirmed by the results of the objective tests and clinical indicators performed in this group. The clinical indicators used to evaluate the oral hygienic condition and the inflammatory condition of the periodontium and the complications occurred after the treatment also showed that the treatment measures carried out in the patients of group III were unsuccessful. According to information of a group of scientists, the failure of endodontic treatment is related to incomplete sealing or oversealing of canals [2, 12]. The second group of experts believe that the composition of temporary and permanent sealing materials for the canals play a significant role in the assessment of the quality of endodontic treatment [2, 10], while the third ones associate the cause of insufficient results during endodontic treatment with the quality lack of chemical-mechanical treatment of the dental root-canal systems [5, 9]. In another study, changes in periapical dental tissues with a focus of periapical destruction were studied with the PAI index. The author determined the best result in reduction of the destruction focus in the main experimental group (from 3.74±0.17 to

1.17±0.12) compared to the control group (from 3.64±0.19 to 1.99±0.2 mm) [4]. In another study [6], propolis-based preparation was used for the regeneration of periapical tissues, in which the PAI index 1 year after treatment compared to the control group (from 3.9±0.15 to 4.0±0, 3 points) in the main group was 1.8±0.02 to 2.1±0.1 points. Comparing the results of these studies with our results, although a similar clinical picture was observed, the results obtained were different. Thus, the point of destruction determined according to PAI was from 2.77±0.136 to 1.20±0.114 points and from 2.50±0.133 to 1.57±0.114 points in the groups where the "closed" treatment method of apical periodontitis was applied; but in patients of the group where "opened" treatment method of apical periodontitis was used it decreased from 2.55±0.185 to 1.80±0.117 points. In patients of the group where both conservative and surgical treatment methods were applied together, PAI decreased slightly (from 2.57±0.125 to 2.06±0.117 points) compared to the previous research groups.

Conclusions

1. In the patients of the groups where the “closed” treatment method of apical periodontitis was In the patients of the group where the “opened” treatment method of apical periodontitis was applied (patients with acute apical periodontitis and periapical abscess), the destruction center decreased from 2.55±0.185 to 1.80±0.117 points.

2. In patients of the group where both conservative and surgical treatment methods were applied together (acute periostitis, acute osteomyelitis), depending on the size of the destruction center, the course of acute inflammation and the anatomical features of the canals, there was a slight decrease due to PAI index compared to the previous groups (from 2.57±0.125 up to 2.06±0.117 points).

Thus, the study showed that in the serous and purulent phases of acute apical periodontitis and during the development of periapical abscess, “closed” and “opened” treatment methods of apical periodontitis, and conservative, surgical intervention and tooth extraction in the treatment of complications of acute apical periodontitis (acute periostitis, acute osteomyelitis, purulent root cyst), were more reliable treatment methods.

References

1. Aliev BF. Karies ve onun agirlashmalarinin yayilmasi ve aparilan mualicenin retrospektiv analizi. Azerbaijan Tibb jurnali. 2020; 3: 29–35. [In Azerbaijan]

2. Zyzov IM, Gazhva SI. Otsenka effektivnosti algoritmov lecheniya destruktivnyh form periodontita, oslozhnennogo kornevoj perforaciej. Sovremennye problemy nauki i obrazovaniya. 2014; 3: 515. [in Russian]

3. Mamedzade RE. Monitoring dinamiki lecheniya zuba s periapikalnoy destruktsiey kostnoy tkani po pokazatelyam opticheskoy densitometrii. Sovremennaya Stomatologiya (Ukraina), 2016; 1(80):18 [in Russian]

4. Mitronin AV, Platonova ASh, Zaushnikova TS. Sovremennaya metodika irrigatsii sistemy kornevykh kanalov. Kathedra. Stomatologicheskoe obrazovanie. 2015; 54:51 [in Russian]

5. Nasirova HB. Kliniko-laboratornoye obosnovanie primeneniya apikompozitsii pri lechenii verkhushechnogo periodontita.[dissertatsiya] 2016; 22. [In Russian]

6. Salmanov IB. Diagnostika oslozhnyonnogo kariesa zubov v voenno-medicinskikh organizatsiyakh. V sbornike: Aktualnye problemy i perspektivy razvitiya stomatologii v usloviyah severa: otv. red. I.D. Ushnickiy – redaktor. 2016; 92. [In Russian]

7. Solovyeva AM. Primenenie modifitsirovannogo periapikalnogo indeksa RAİ dlya otsenki rezultatov endodonticheskogo lecheniya postoyannykh zubov s nezaverennym formirovaniem korney. Parodontologiya. 1999; 3(13): 50 [In Russian]

8. Tokmakova SI, Lunicyna YuV, Semenkov VA. Sravnitelnaya otsenka kachestva mekhanicheskoy obrabotki kornevykh kanalov zubov sistemami, vrashchayushchikhsya nikeltitanovykh instrumentov. Problemy stomatologii. 2015;1: 20–22. [In Russian]

9. Buchanan LS. FOCUS ON: Endodontics. Dent Today. 2015; 12(34):14.

10. Chugal N. Endodontic treatment outcomes. Dent. Clin. North Am. 2017; 1(61):59-80.

11. Kostyrenko OP, Melnik VL, Shevchenko VK, Sylenko YuI, Yeroshenko GA. Application of nanocrystals in treatment of chronic apical periodontitis. World of Medicine and Biology. 2020; 3 (73): 61–64.

12. Papantonopoulos G, Takahashi K, Bountis T, Loos BG. Artificial Neural Networks for the Diagnosis of Aggressive Periodontitis Trained by Immunologic Parameters, PLoS ONE 2014; 9(3): e89757. Doi:10.1371/j.pone.2014. 0089757.

13 Zeng C. Antimicrobial efficacy of an apical negative pressure root canal irrigation system against intracanal microorganisms. J. Dent. 2018; 72:71–75.

Стаття надійшла 12.09.2021 р.