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PATHOMORPHOLOGICAL CHANGES OF THE ROOT CEMENTUM OF THE TEETH AGAINST THE BACKGROUND OF INFECTIOUS-INFLAMMATORY PROCESSES

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Root cementum plays an important role in the regeneration of the periodontal complex. The purpose of the work was to study the pathomorphological changes of the root cementum of the teeth against the background of infectious-inflammatory processes in the periodontal tissues and mechanical influence on the root surface during periodontal treatment. The study material was 30 teeth with generalized periodontitis. According to the results of scanning electron microscopy, the surface of the teeth roots with generalized periodontitis had a heterogeneous appearance. Using area-specific Gracey curettes, the surface of the roots was smooth. Under the influence of the magnetostrictive ultrasonic scaler, the surface of the roots had a corrugated appearance. The surface of the roots after the application of magnetostrictive ultrasonic scaler and area-specific Gracey curettes was smooth with the presence of scales. According to the results of cementum morphometry of teeth longitudinal sections, a significant effect of area-specific Gracey curettes on the thickness of root cementum was established. Significant reduction in the thickness of root cementum in combination with increased masticatory load due to traumatic occlusion and low regenerative properties of cervical root cementum is a factor in the development of hyperesthesia and cervical lesions.

Key words: periodontitis, cementum, microscopy, active periodontal treatment, regeneration.

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ПАТОМОРФОЛОГІЧНІ ЗМІНИ ЦЕМЕНТУ КОРЕНЯ ЗУБІВ НА ТЛІ ІНФЕКЦІЙНО-ЗАПАЛЬНИХ ПРОЦЕСІВ

Цемент кореня відіграє важливу роль в процесах регенерації пародонтального комплексу. В даному досліджені вивчали патоморфологічні зміни цементу коренів зубів на тлі інфекційно-запальних процесів в тканинах пародонта та механічної обробки поверхні коренів при проведенні пародонтологічного лікування. Матеріалом дослідження стали 30 зубів з генералізованим пародонтитом II–III ступеня тяжкості. За результатами скануючої електронної мікроскопії поверхня коренів зубів з генералізованим пародонтитом мала неоднорідний вигляд. При застосуванні зоноспецифічних кюрет Грейсі поверхня коренів зубів була гладкою. Під впливом магнітострикційного ультразвукового скалера поверхня коренів зубів мала рифлений вигляд. Поверхня коренів після застосування магнітострикційного ультразвукового скалера та зоноспецифічних кюрет Грейсі була гладкою з наявністю лусочок. За результатами морфометрії цементу поздовжніх шліфів зубів встановлено значний вплив зоноспецифічних кюрет Грейсі на товщину цементу коренів. Достовірне зменшення товщини цементу коренів зубів в поєднанні з підвищеним жувальним навантаженням внаслідок травматичної оклюзії та низькими регенеративними властивостями цементу пришийкової частини кореня зуба є чинником розвитку гіперестезії та цервікальних уражень.

Ключові слова: пародонтит, цемент, мікроскопія, первинне пародонтологічне лікування, регенерація.

The work is a fragment of the research project "Clinical and laboratory substantiation of the use of modern medical technologies in the complex treatment and rehabilitation of major dental diseases", state registration No. 0117U006451.

The main purpose of treating patients with periodontitis is the elimination of microbial biofilm on the teeth roots surface. Biofilm microorganisms are attached to the root surface by selective adhesion and produce exotoxins that cause toxic effects on tooth root cementum and cause microcirculatory disorders in periodontal tissues, damaging its structural elements [5].

The cementum is a mineralized tissue that covers the tooth root and together with the periodontal ligament attaches the teeth to the alveolar bone [4]. Chronic inflammation in periodontal tissues causes destruction of the periodontal supportive tissues and exposure of the teeth roots surface. As a result of environmental factors, root cementum undergoes both structural changes and changes in its chemical composition.

According to the difference in the density of cells and organic fibers in the matrix, root cementum is histologically divided into five types [10]. The acellular afibrillar cementum consists of a matrix, but does not contain collagen fibers and cells, is deposited in the form of isolated spots on small areas of enamel and dentin, and does not perform any function in the attachment of teeth [2].

The acellular extrinsic fiber cementum is located in the neck and the upper two-thirds of the tooth root, consists of a mineralized matrix and a large number of collagen fibers, which are arranged in dense bundles. On the one side, these bundles pass into the fibers of dentin, on the other side – in bundles of collagen fibers of periodontal ligaments and further – in Sharpey's fibers of an alveolar bone. A large number of fibers indicates a significant role of this type of cementum in the attachment of teeth to bone tissue [10, 2].

The cellular intrinsic fiber cementum is located on the apex of the tooth roots and is characterized by the presence of cementoblasts, cementocytes and own collagen fibers. Cellular intrinsic fiber cementum plays an important role in cementum regeneration, is found in resorption defects and root fractures. In rare cases, intrinsic cementum does not contain cementocytes, consists entirely of collagen fibers and is called acellular intrinsic fiber cementum [10, 2]. The cellular mixed stratified cementum is a combination of cellular intrinsic fiber cementum and acellular extrinsic fiber cementum, the layers of which overlap [2].

In periodontitis, elimination of microbial biofilm is achieved by smoothing and polishing the surface of teeth roots using manual and mechanical tools: ultrasonic and sonic scalers and curettes. The use of certain types of tools has a significant impact on the tooth root surface, which is contaminated with microorganisms. The organic cementum matrix is similar to the matrix of bone tissue: cementoblasts express bone matrix proteins – osteocalcin, osteopontin and sialoprotein; in addition, growth factors are in the mineralized cementum matrix, as a result of which the tooth root cementum plays an important role in the regeneration of periodontal tissues and the creation of new attachment [7, 8].

One of the key elements in achieving successful regeneration of periodontal tissues is delicate work in the subgingival area and prevention of root cementum damage during the supportive periodontal treatment, when instrumental work increases the risk of destruction of tooth root cementum.

The purpose of the work was to study the pathomorphological changes of the root cementum of the teeth under the influence of infectious and inflammatory processes in periodontal tissues and mechanical treatment of the surface of the roots during periodontal treatment.

Materials and methods. The study involved 14 patients diagnosed with generalized periodontitis, II and III stage during the active periodontal treatment from whom 24 single-rooted teeth were extracted for periodontal and orthopedic indications (with informed consent), and 4 patients diagnosed with generalized periodontitis, II and III stage during the supportive periodontal treatment from whom through 3 months after the active periodontal treatment 6 teeth were extracted for periodontal and orthopedic indications (with informed consent). All participants underwent periodontal examination using the Florida Probe system (Florida Probe Corp., Gainesville, FL).

The ultrastructural study was performed on 30 single-rooted teeth of the upper and lower jaws. The surface of teeth roots in patients with generalized periodontitis at the stage of active periodontal treatment after various types of instrumental treatment and 3 months after active periodontal treatment was examined using a scanning electron microscope Tescan Mira 3 LMU (TESCAN ORSAY HOLDING, Czech Republic). The thickness of the root cementum was measured on the longitudinal sections of the teeth. Measurement of the root cementum thickness was performed in the upper third of the teeth roots. 48 longitudinal sections of teeth obtained from 24 single-rooted teeth were examined.

V series of studies on 6 teeth in each depending on influence on surface of the teeth roots were carried out. The I series of studies included extracted teeth for periodontal indications (III degree of mobility) after periodontal treatment using magnetostrictive ultrasonic scaler Cavitron (Dentsply Sirona, USA). The II series of studies included teeth treated with the Cavitron magnetostrictive ultrasonic scaler and area-specific Gracey curettes. The III series of studies included teeth whose surface was treated with area-specific Gracey curettes. The IV series of studies was a control group, which included 6 teeth with generalized periodontitis, the surface of which was not subject to instrumental influence.

To determine the long-term results of microbial exposure and instrumental treatment of teeth, samples of teeth were extracted 3 months after the active periodontal treatment at the stage of supportive treatment before orthopedic treatment. The V series of studies included samples of 6 teeth extracted for orthopedic indications.

Tooth samples preparation protocol. Tooth samples were immersed in 2.5 % glutaraldehyde solution for 24 hours and treated with sodium hypochlorite to remove organic deposits. Dehydration of the samples was performed according to the standard histological protocol in a series of increasing ethanol concentrations, after which the samples were dried at the critical point of CO_2. To obtain longitudinal sections of the teeth, the samples were embedded in epoxy resin. Longitudinal sections of teeth were obtained using a MicraCut 151 device (Metkon, Turkey). The sections were polished and coated with a thin layer of Au/Pd alloy 30 nm thick in the PECS Model 682 device (Gatan, Germany).

Using a Tescan Mira 3 LMU scanning electron microscope equipped with an Oxford X-Max 80 mm^2 energy-dispersive spectrometer at an accelerating voltage of 10 kV the surface of the cementum of the roots of teeth was studied from the cementoenamel junction to the root apex. Morphometric measurements of the thickness of the upper third of the cementum were carried out on longitudinal sections of the teeth.

Statistical analysis was performed using the R programming language (version 3.6.3). Descriptive statistics were performed for all indicators. The mean and standard deviation (M±SD) were used to

represent the age and values of the root cementum thickness. Statistical significance between groups was determined by the Kruskal-Wallis method. Holm's method was used for multiple comparisons. A statistically significant difference was considered at $p<0.05$ level.

Results of the study and their discussion. The study group included 18 patients (8 women and 10 men) with generalized periodontitis, II and III stage. The mean age of the examined patients was 44.78±7.00 years. Before the periodontal treatment during the clinical examination of the patients, the mean value of gingival recession was 1.74±1.04 mm, periodontal pocket depth – 5.22±1.17 mm, clinical attachment loss – 6.97±1.15 mm. In 3 months, during the clinical examination of the patients after active periodontal treatment, the mean value of gingival recession was 2.36±0.41 mm, periodontal pocket depth – 3.92±0.36 mm, clinical attachment loss – 6.27±0.33 mm.

According to the results of scanning electron microscopy the cementum surface of the teeth roots of the I series of studies under the influence of magnetostrictive scaler was corrugated with a large number of defects – notches, small grooves and scratches, and with an absence of periodontal fibers (fig. 1).

In the samples of the II series of studies, the cementum surface of the roots under the influence of magnetostrictive scaler and area-specific Gracey curettes had a smoother appearance, however, in some samples on the cementum surface were scales and small notches. The absence of periodontal fibers was also observed (fig. 2).

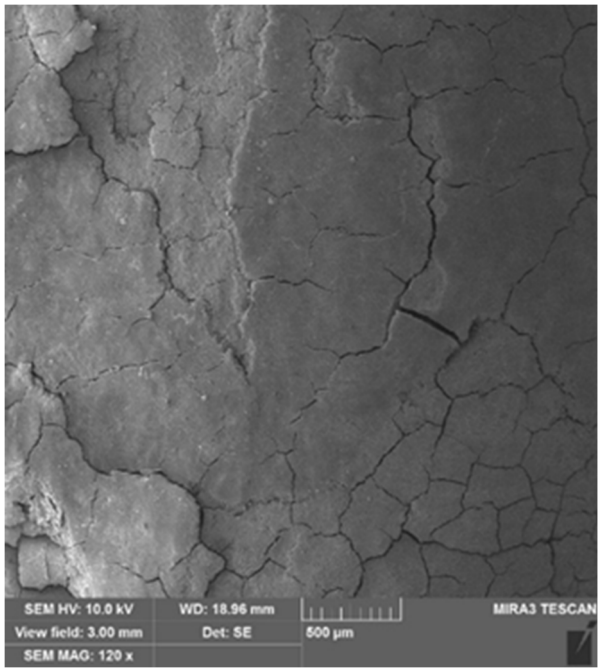


Fig. 1. Scanning electron microscopy of the upper third of the root under the influence of magnetostrictive ultrasonic scaler, a heterogeneous cementum surface of the tooth root with areas of resorption was observed (× 120).

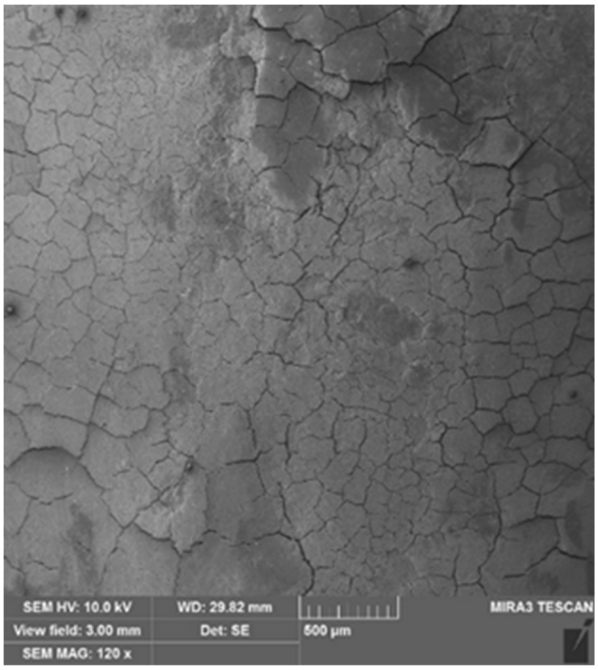


Fig. 2. Scanning electron microscopy of the upper third of the root under the influence of a magnetostrictive scaler and area-specific Gracey curettes, the cementum surface of the tooth root was smooth, there were small areas with a scaly surface (× 120).

The cementum surface of the teeth roots of the samples of the III series of studies using area-specific Gracey curettes was smooth with a small number of corrugations and with a complete absence of periodontal fibers. A substantial number of scratches were observed on the cementum surface. Some samples had exposed dentinal tubules as a result of the removal of significant amounts of cementum (fig. 3).

In the samples of the IV series of studies, the cementum surface of the teeth roots in patients with generalized periodontitis was heterogeneous and rough, with different defects of different depths, covered with a microbial biofilm, which is represented by a combination of different types of bacteria. In addition, on the cementum surface, the roots were hard dental deposits in the form of calculus of various sizes. The absence of periodontal fibers was noted on the surface of the cementum. In some areas, cementum resorption was observed.

According to the results of the morphometry of the cementum (on longitudinal sections), it was found that the thickness of the cementum in the upper third of the teeth roots of the samples of IV series of studies was 44.09±15.32 µm. In the samples of the I series of studies, the mean thickness of the cementum in the upper third of the roots, which were treated with a magnetostrictive ultrasonic scaler, was 23.56±3.63 µm, while the thickness of the cementum of the teeth roots under the influence of a magnetostrictive ultrasonic scaler and area-specific Gracey curettes was 17.40±4.82 µm. The thickness of the cementum of

the teeth roots, which were treated with area-specific Gracey curettes, was the lowest, its mean values were 5.47±3.35 μm.

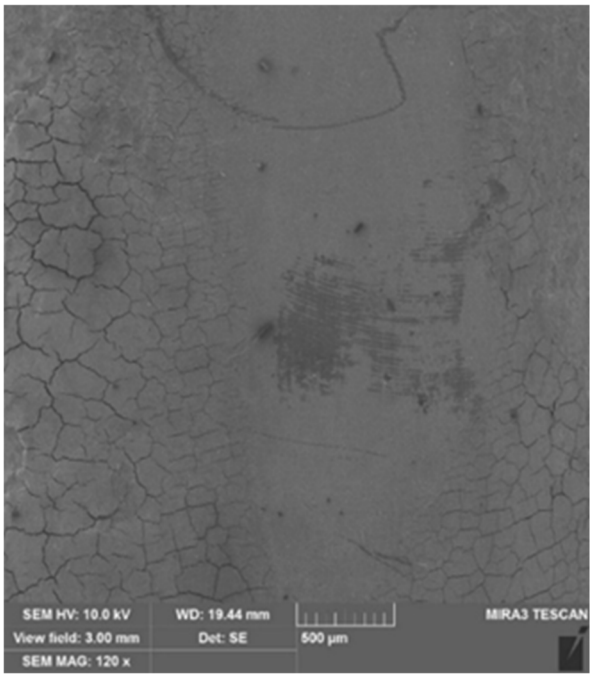


Fig. 3. Scanning electron microscopy of the upper third of the root using area-specific Gracey curettes, the cementum surface of the tooth root was smooth and clean (× 120).

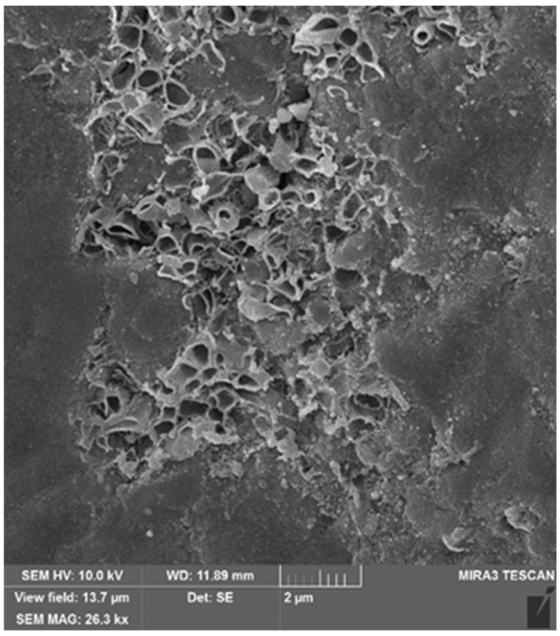
There was a significant difference in the thickness of the cementum of the upper third of the teeth roots between the IV series of studies, which included samples of teeth whose cementum surface was not exposed to instruments and III series of studies, in which samples were treated with area-specific Gracey curettes (p=0.013). A significant difference in the thickness of the cementum of the upper third of the teeth roots was observed between IV series and II series of studies in which the samples were exposed to magnetostrictive ultrasonic scaler and area-specific Gracey curettes (p=0.013). Between the III series of studies, in which the samples were treated with area-specific Gracey curettes and the I series of studies, in which the cementum of the roots was treated with a magnetostrictive ultrasonic scaler, there was also a significant difference in the thickness of the cementum of the roots (p=0.020). A significant difference in the thickness of the cementum of the upper third of the roots was observed between the III series of studies, in which the samples were treated with area-specific Gracey curettes, and the II series of studies, in which the cementum of the roots was treated with an ultrasonic magnetostrictive scaler and area-specific Gracey curettes (p=0.020). Between the IV series of studies and the I series of studies, as well as between the I series of studies and the II series of studies, a significant difference in the thickness of the cementum of the upper third of the teeth roots was close to significant (p=0.065, p=0.061, respectively).

The influence of microbial factor on the teeth roots surface after the active periodontal treatment at the stage of the supportive periodontal treatment was studied (V series of studies). Due to clinical attachment loss, the exposed roots surface of the teeth after active periodontal treatment is negatively affected by soft plaque, pH changes in the oral fluid, the use of acidic foods, carbonated drinks, and other factors. Using scanning electron microscopy, the pathomorphological changes of the cementum of the teeth roots were studied on samples of teeth extracted 3 months after the active periodontal treatment. According to the results of the study, on the surface of the upper third of the teeth roots, a thinning of the cementum of the roots and the presence of resorption lacunas formed as a result of the action of the microbial biofilm were found (fig. 4). In the areas of resorption, lacunas exposed dentin of the teeth roots was observed, which clinically caused hyperesthesia of the hard tissues of the teeth in patients. Colonies of microorganisms were found on the surface of dentin and dentinal tubules.

This study was carried out on extracted teeth in patients with generalized periodontitis at the stage of active periodontal treatment using mechanical instruments and 3 months later at the stage of supportive periodontal treatment. The cementum of the root of teeth in patients with generalized periodontitis contains endotoxins, which, due to toxic effects, prevent the attachment of fibroblasts to the root surface and, as a result, the regeneration of the periodontal complex; the presence of a rough surface of the root cementum contributes to a higher and faster accumulation of bacterial plaque [5]. Periodontal treatment, which aims at smoothing and polishing the teeth roots, plays an important role in the treatment of periodontal diseases, and the presence of a smooth surface of the root cementum after mechanical action contributes to the formation of a new attachment.

Analysis of the morphology of the cementum of the roots after the impact on its surface of mechanical and manual instruments showed differences in surface roughness between samples of the teeth of all series of studies. The teeth roots surface of the III series of studies in which the cementum surface was treated with area-specific Gracey curettes showed the greatest smoothness, due to the sharp cutting edge of the working surface of the curettes and the applied pressure required to remove contaminated cementum and hard subgingival dental plaque. The least smoothness of roots cementum was observed on the teeth of the I series of studies, the samples of which were exposed to a magnetostrictive ultrasonic

scaler, which is explained by the corresponding mechanism of action based on cavitation, machining, irrigation, and acoustic turbulence of the tip, due to that it requires applying less pressure.



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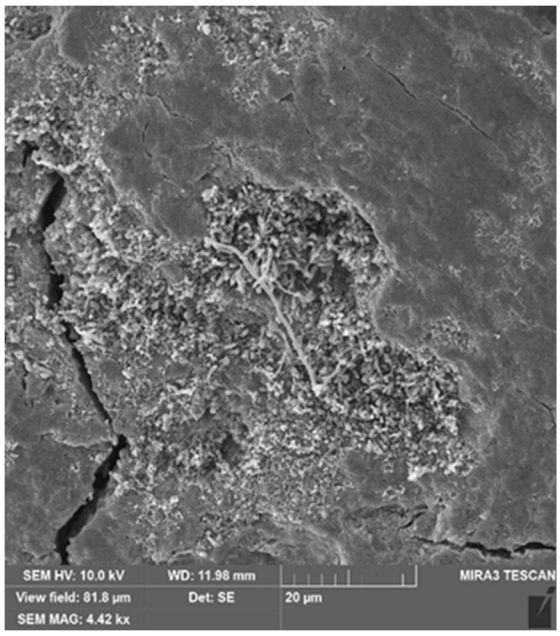

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Fig. 4. Resorption lacuna on the tooth root surface in patients with generalized periodontitis through 3 months after active periodontal treatment (according to the results of scanning electron microscopy). Note: a) resorption lacuna on the surface of the tooth root (× 26300); b) dentin exposure, the presence of microflora on the surface of the resorption lacuna and in the dentinal tubules (× 4420).

The use of scanning electron microscopy permitted to detection of bacterial invasion of the cementum of the teeth roots and radicular dentin after active periodontal treatment. According to Adriaens et al. bacterial invasion can begin as a local process involving both one microorganism only and a large number of microorganisms that were present in lacunar defects of root cementum, which spread to the radicular dentin [1]. On 11 samples of teeth, bacteria entered the dentinal tubules, on 2 samples – microorganisms were found on the wall of the pulp chamber. In addition, the microflora of periodontal pockets can be a major source of infections in the root canal [9]. This indicates that the affected dentin tubules and lacunas serve as bacterial reservoirs, from which a re-colonization of treated surfaces of teeth roots occurs.

Evaluation of the effect of instrumentation on the cementum surface of the teeth roots showed that mechanical and manual processing affects the thickness of the cementum. Working with a magnetostrictive ultrasonic scaler eliminated less root cementum compared to area-specific Gracey curettes. These findings are consistent with studies by Bozbay et al. and Maritato et al. [3, 6]. Considering that the cementum of the root in patients with generalized periodontitis is thinner, during the instrumentation of the cementum surface it is possible to remove the cementum of the root with underlying dentin, followed by exposure of the dentinal tubules. Given the presence of biologically active mediators in the composition of bone tissue and tooth root cementum, the constant instrumental impact on the cementum surface of the root can lead to a significant loss of its thickness and loss of biomechanical features that play a significant role in the processes of fixation of the tooth and the regeneration of the periodontal complex.

Conclusions

1. Infectious and inflammatory processes in periodontal tissues, microbial factors, changes in the pH of the oral fluid, clinical attachment loss cause structural changes in the cementum. Preservation of cementum of the teeth roots provides successful regeneration of periodontal tissues.

2. Structural changes of the cementum of the roots of teeth and its significant thinning occur under the influence of mechanical treatment during the active periodontal treatment. The magnetostrictive ultrasonic scaler had the least effect on the thickness of the cementum, and the use of area-specific Gracey curettes significantly thinned the thickness of the cementum and, in some cases, facilitated its removal.

3. Damage to the cementum of the teeth roots in patients with generalized periodontitis is the structural basis of the low regenerative potential of cementum, which is explained by the peculiarities of acellular cementum in the cervical area, clinical attachment loss, and the influence of microorganisms. A significant decrease in the thickness of the cementum of the teeth roots in combination with an increased chewing load due to traumatic occlusion and low regenerative properties of the cementum of the cervical part of the teeth roots is a factor in the development of hyperesthesia and cervical lesions.

References

1. Adriaens PA, Edwards CA, de Boever JA, Loesche WJ. Ultrastructural observations on bacterial invasion in cementum and radicular dentin of periodontally diseased human teeth. J Periodontol. 1988; 59(8): 493–503. doi: 10.1902/jop.1988.59.8.493.
2. Arzate H, Zeichner-David M, Mercado-Celis G. Cementum proteins: role in cementogenesis, biomineralization, periodontium formation and regeneration. Periodontol 2000. 2015; 67(1): 211–233. doi: 10.1111/prd.12062.
3. Bozbay E, Dominici F, Gokbuget AY. Preservation of root cementum: a comparative evaluation of power-driven versus hand instruments. Int J Dent Hyg. 2018; 16: 202–209. doi: 10.1111/idh.12249.
4. Foster BL. On the discovery of cementum. J Periodontal Res. 2017; 52(4): 666–685. doi: 10.1111/jre.12444.
5. Larsen T, Fiehn NE. Dental biofilm infections – an update. *APMIS.* 2017; 125(4): 376–384. doi: 10.1111/apm.12688.
6. Maritato M, Orazi L, Laurito D, Formisano G, Serra E, Lollobrigida M, Molinari A, De Biase A. Root surface alterations following manual and mechanical scaling: a comparative study. Int J Dent Hyg. 2018;16(4): 553–558. doi: 10.1111/idh.12349.
7. Menicanin D, Hynes K, Han J, Gronthos S, Bartold PM. Cementum and periodontal ligament regeneration. Adv Exp Med Biol. 2015; 881: 207–236. doi: 10.1007/978-3-319-22345-2_12.
8. Nuñez J, Vignoletti F, Caffesse RG, Sanz M. Cellular therapy in periodontal regeneration. Periodontol 2000. 2019; 79(1): 107–116. doi: 10.1111/prd.12250.
9. Stauffacher S, Lussi A, Nietzsche S, Neuhaus KW, Eick S. Bacterial invasion into radicular dentine – an in vitro study. Clin Oral Invest. 2016; 21(5): 1743–1752. doi: 10.1007/s00784-016-1960-7.
10. Yamamoto T, Hasegawa T, Yamamoto T, Hongo H, Amizuka N. Histology of human cementum: Its structure, function, and development. Jpn Dent Sci Rev. 2016; 52(3): 63–74. doi: 10.1016/j.jdsr.2016.04.002.

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PRIMARY CHEILITIS: PATHOGENETIC APPROACHES TO TREATMENT

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Primary cheilitis is widespread among all lip diseases. The article presents known methods of treatment and maintenance therapy of cheilitis and offers its own methods of treatment and maintenance therapy of meteorological and actinic cheilitis in patients. Pathogenetic therapy has the main task of achieving long-term control over the symptoms of meteorological and actinic cheilitis, aimed at preventing exacerbations of the disease during the year. All patients in the observation group received comprehensive therapy and were recommended to undergo maintenance therapy 3, 6 and 9 months after the main course of cheilitis treatment. Treatment was considered effective in achieving positive results in the subjective and objective picture of the disease. The data obtained indicate that the drug tiotriazoline should be used in the medical treatment of patients with meteorological and actinic cheilitis. The necessity not only of local treatment, but also of its systemic application in complex therapy is proved. For the general therapy of actinic cheilitis for the purpose of hyposensitizing effect it is expedient to appoint antihistamines of the third generation.

Key words: primary cheilitis, meteorological cheilitis, actinic cheilitis, treatment, maintenance therapy.

А.В. Марченко

ПЕРВИННІ ХЕЙЛІТИ: ПАТОГЕНЕТИЧНІ ПІДХОДИ ДО ЛІКУВАННЯ

Первинні хейліти широко розповсюджені серед усіх захворювань губ. В статті надані відомі способи лікування та підтримувальної терапії хейлітів та запропонувано власні методи лікування та підтримувальної терапії метеорологічного та актинічного хейлітів у пацієнтів. Патогенетична терапія має основним завданням досягнення довгострокового контролю над симптомами метеорологічного та актинічного хейлітів, спрямована на запобігання загострень хвороби протягом року. Усім пацієнтам групи спостереження була проведена комплексна терапія та рекомендовано через 3, 6 та 9 місяців після проведення основного курсу лікування хейліту пройти підтримувальну терапію. Лікування вважали ефективним при досягненні позитивних результатів у суб'єктивній та об'єктивній картині захворювання. Отримані дані свідчать, що препарат тіотріазолін доцільно використовувати при медикаментозному лікуванні пацієнтів з метеорологічним та актинічним хейлітами. Доведена необхідність не лише місцевого лікування, але й системного його застосування у комплексній терапії. Для загальної терапії актинічного хейліту з метою гіпосенсибілізуючого ефекту доцільно призначати антигістамінні засоби третього покоління.

Ключові слова: первинні хейліти, метеорологічний хейліт, актинічний хейліт, лікування, підтримувальна терапія.

The work is a fragment of the research project "Development of pathogenetic prevention of pathological changes in the oral cavity of persons with internal diseases", state registration No. 0121U108263).

The high prevalence of primary cheilitis among all lip diseases, which according to many studies reaches 40–55 %, determines the relevance of this problem [1, 2, 3]. Primary (independent) cheilitis, according to the classifications of Maksymenko PT (Poltava, 1998) and NMU (Kyiv, 1998) include: meteorological, actinic, glandular cheilitis, chronic cleft lip and lymphedema [1].