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USING A SOFTWARE PACKAGE FOR PREDICTING THE STATE OF THE INTERDENTAL GINGIVAL PAPILLA IN PATIENTS WITH GENERALIZED PERIODONTITIS AFTER RESTORATION OF THE CONTACT SURFACES OF THE POSTERIOR TEETH

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The study was devoted to the analysis the possibilities of a software product to determine the probability of preserving or restoring interdental gingival papillae depending on the parameters of the elements of the interdental triangle during the direct restoration of caries-affected contact surfaces of the posterior teeth in patients with generalised periodontitis of the initial and initial-I degree of severity. The clinical trial involved 150 patients aged 18 to 45 years. To predict the likelihood of preserving or restoring interdental papillae during the restoration of the contact surfaces of the posterior teeth in patients with generalised periodontitis, the Papillary Expert software product was developed and clinically tested. The developed software provided a high level of accuracy in predicting the preservation or restoration of interdental gingival papillae after restoration of the contact surfaces of posterior teeth in patients with generalized periodontitis, thereby aiding in selecting the most effective treatment strategies.

Key words: caries, treatment, contact surfaces, generalized periodontitis, programming.

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ВИКОРИСТАННЯ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ ДЛЯ ПРОГНОЗУВАННЯ СТАНУ

МІЖЗУБНИХ ЯСЕННИХ СОСОЧКІВ У ПАЦІЄНТІВ З ГЕНЕРАЛІЗОВАНИМ

ПАРОДОНТИТОМ ПІСЛЯ ВІДНОВЛЕННЯ КОНТАКТНИХ ПОВЕРХОНЬ ЗАДНІХ ЗУБІВ

Дослідження було присвячено аналізу можливостей програмного продукту для визначення ймовірності збереження або відновлення міжзубних ясенних сосочків залежно від параметрів елементів міжзубного трикутника при прямій реставрації уражених каріесом контактних поверхонь бічних зубів у пацієнтів з генералізованим пародонтизом початкового та початкового-I ступеня тяжкості. У клінічному дослідженні взяли участь 150 пацієнтів віком від 18 до 45 років. Для прогнозування ймовірності збереження або відновлення міжзубних сосочків при реставрації контактних поверхонь бічних зубів у пацієнтів з генералізованим пародонтизом був розроблений і клінічно апробований програмний продукт «Papillary Expert». Розроблене програмне забезпечення забезпечило високий рівень точності прогнозування збереження або відновлення міжзубних ясенних сосочків після реставрації контактних поверхонь бічних зубів у пацієнтів з генералізованим пародонтизом, тим самим допомагаючи у виборі найбільш ефективних стратегій лікування.

Ключові слова: карієс, лікування, контактні поверхні, генералізований пародонтизм, програмування.

The work is a fragment of the research project “Clinical and laboratory substantiation of the newest approaches in diagnostics, prevention and treatment of basic dental diseases” state registration No. 0118U006672.

In modern medical practice, information technologies are increasingly used, which are now becoming an integral part of the work of a dentist of any specialty. The assessment of dental status using digital photography, according to 3D examination data in combination with computer image analysis technology is innovative and is intensively developing as a direction of the medical and diagnostic process [2].

A condition for the normal functioning of any body system is the perfection of its morphological and functional relationships [5]. One of the leading criteria for the successful treatment of caries of the contact surfaces of the posterior teeth in patients with generalized periodontitis is the preservation or restoration of the interdental gingival papilla, and this is possible provided that certain relationships are maintained between the components of the periodontal complex with the obligatory preservation of each

structural and functional component of the periodontium, of which the hard tissues of the tooth are a part. The absence of such interaction significantly affects the development of generalized periodontitis [6, 7].

Prediction of the results of treatment of caries of the contact surfaces of the posterior teeth in patients with generalized periodontitis, namely the restoration of the interdental papilla, using a software product will allow you to choose the most rational method of tooth filling, taking into account the parameters of the periodontal complex of the interdental triangle and will help to increase the effectiveness of complex treatment of generalized periodontitis [4].

The purpose of the study was to analyze the possibilities of a software product to determine the probability of preserving or restoring interdental gingival papillae depending on the parameters of the elements of the interdental triangle during direct restoration of caries-affected contact surfaces of the posterior teeth in patients with generalised periodontitis of the initial and initial-I degree of severity.

Materials and methods. The clinical trial involved 150 patients aged 18 to 45 years, including 85 women (57 %) and 65 men (43 %). The research was conducted in 2018–2023. Informed consent to participate in the study was obtained from all patients. The examined patients had previously diagnosed and radiographically confirmed generalised periodontitis (GP) of the initial and initial – I severity. The study did not include patients under 18 and over 45 years of age, patients with severe somatic pathology, cancer and blood diseases, HIV infection, mental illness, alcohol and drug addiction, as well as symptomatic hypertrophic gingivitis, and GP I, II and III severity.

The examined individuals were divided into two groups: Group I (main) – 122 patients with generalised periodontitis of initial and initial – I severity with carious lesions and restorations of the contact surfaces of the posterior teeth, Group II (comparison) – 28 patients with generalised periodontitis of the same severity without carious lesions and restorations according DMFT index.

All studies were conducted in compliance with the main provisions of Good Clinical Practice (1996), the Council of Europe Convention on Human Rights and Biomedicine (1997), the World Medical Association's Declaration of Helsinki on the Ethical Principles for Scientific Medical Research Involving Human Subjects (1964–2013), and the Ministry of Health of Ukraine's orders No. 690 of 23.09.2009 and No. 616 of 03.08.2012.

In patients with generalised periodontitis, the periodontal biotype was determined (Ochsenbein C., 1969), the degree of gingival inflammation by the PMA index (Parma C., 1960), bleeding of the interdental gingival papillae by the Papillary Bleeding Index (PBI; Mühlemann H, 1975), the volume of interdental papillae in four degrees according to the Papilla Index Score (PIS; Jemt R., 1999), the width of keratinised

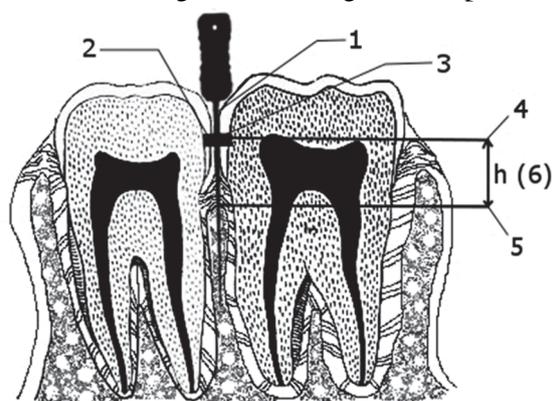


Fig. 1 Scheme of measuring the contact-alveolar height.
1 – spreader No. 15; 2 – silicone length limiter; 3 – floss tip;
4 – contact point; 5 – alveolar bone; 6 – contact-alveolar height.

The proposed cervical-proximal index was determined by cone-beam computed tomography. In the digital image, the horizontal distance from the enamel-cement border of one tooth to the same border of the adjacent tooth was measured.

After the examination, all patients underwent primary periodontal treatment, which included instrumental and hardware scaling, local anti-inflammatory therapy, elimination of supracontacts, and selection of personal oral hygiene products.

To predict the likelihood of preserving or restoring interdental papillae during the restoration of the contact surfaces of the posterior teeth in patients with generalised periodontitis, the Papillary Expert software product was developed and clinically tested [2]. The software was written using the Borland Delphi 6.0 toolkit of the Windows information system in the Ukrainian interface language. The software product determined the probability of preservation or restoration of gingival papillae according to 6 criteria,

namely: the width of the keratinised gingiva, contact-alveolar height, cervical-proximal index, periodontal biotype, periodontal pocket depth and the degree of interalveolar bone resorption. The program consistently analysed and compared the indicators, formed a response that reflected the predicted volume of the interdental gingival papilla in percentage terms and demonstrated its appearance with the input data.

For the statistical processing of the results, the methods of variation statistics were used with the use of the software STATISTICA 6.0 and Microsoft Office Excel. Statistical processing of the experimental study results was carried out by the methods of variation analysis using the Student's test. The difference was considered statistically significant at $p < 0.05$ [3].

Results of the study and their discussion. During the dental examination of 150 patients with generalised periodontitis of the initial and initial – 1 degree, it was found that the prevalence of carious lesions of the contact surfaces of the posterior teeth was 82.6 % (high level according to WHO criteria), the intensity index for these surfaces of the posterior teeth was 14.6 ± 0.2 (also high level). In each patient with generalized periodontitis, on average, the number of posterior teeth with unsealed carious cavities on the contact surfaces (component D) was 5.8 ± 0.2 , which was significantly ($p < 0.05$) more than the number of posterior teeth with filled cavities on these surfaces (component F), which was 5.0 ± 0.1 , while the average number of extracted teeth (component M) was 3.8 ± 0.3 ($p < 0.05$).

Indices of gingival inflammation in the area between the posterior teeth with carious lesions and restorations of contact surfaces in the examined patients of group I corresponded to the average degree: the PMA index was 40.1 ± 1.2 %, the papillary bleeding index PBI was 2.6 ± 0.1 points. In patients of group II with intact contact surfaces of the posterior teeth, the PMA index in such interdental spaces was significantly ($p < 0.05$) lower and amounted to 19.5 ± 1.2 %, the PBI bleeding index of interdental papillae was 2.4 ± 0.2 points, which corresponded to a mild degree of inflammation.

The analysis of the results of the study of the state of the periodontal complex in patients with generalised periodontitis revealed changes in the anatomical and topographic parameters of the components of the interdental triangles in the presence of carious lesions and restorations of the contact surfaces of the posterior teeth. In particular, on average, the width of the keratinized gingiva in the area of the posterior teeth in patients with generalized periodontitis of the initial and initial – I degree with carious lesions and restorations of the contact surfaces of the posterior teeth (group I) in the lower jaw was 2.7 ± 0.1 mm, on the upper jaw – 3.1 ± 0.2 mm, in patients with HP with intact contact surfaces (group II) – 3.0 ± 0.2 mm and 3.6 ± 0.1 mm, respectively (the indicators for the upper jaw differed significantly, $p < 0.05$). It was found that 146 patients (97.3 % of the total number of subjects in both groups) had a thick periodontal biotype, 4 patients (2.7 %) had a thin one.

The condition of the interdental gingival papillae in the area of the contact surfaces of the posterior teeth affected by caries or with existing restorations was assessed in patients of group I, PIS index revealed the complete absence (PIS index – 0 degree) of 82 papillae (23.5 % of the total number of subjects), 114 proximal spaces (32.7 %) had interdental gingival papillae preserved by less than 1/2 of the volume (PIS index – 1 degree), they filled the interdental space significantly below the contact point, in 98 spaces (28.1 %) the volume of the papillae was more than 1/2 (PIS index – 2 degree), they practically approached the contact point with their apices, 55 interdental gingival papillae (15.7 %) completely retained their volume (PIS index – 3 degree), the papillae filled the proximal spaces to the contact point and adhered firmly to the contact surfaces of the teeth. It is important that in the proximal spaces with less than or more than 1/2 of the interdental gingival papillae preserved (PIS index 1 and 2 degrees), the contact point and anatomical shape of the restorations needed to be corrected.

In patients of group II, 20 interdental gingival papillae (9.0 % of all examined) completely lost their volume (PIS index – 0 degree), with no contact point between the teeth, 23 interdental gingival papillae (10.2 %) retained their volume by less than 1/2 (PIS index – 1 degree), 112 interdental gingival papillae (50.0 %) – by more than 1/2 (PIS index – 2 degree), 69 interdental gingival papillae (30.8 %) completely retained their volume (PIS index – 3 degree). The number of preserved gingival papillae in the examined proximal spaces of patients in group I compared to those in group II was 2 times less, while the absence of interdental gingival papillae was detected 2.5 times more often.

In patients of group I, in the area of the lateral teeth with contact surfaces affected by caries or with restorations, in 82 interdental spaces (23.5 % of the number of subjects) with a complete absence of gingival papillae (PIS index – 0 degree), the contact-alveolar height was significantly ($p < 0.05$) highest and amounted to 7.6 ± 0.1 mm, in 55 interdental spaces (15.7 %) with fully preserved interdental gingival papillae that filled the proximal spaces to the contact point and firmly adhered to the contact surfaces of the adjacent teeth (PIS index – 3 degree), the average value of the contact-alveolar height was 3.5 ± 0.1 mm, i.e. 2 times lower ($p < 0.05$). In patients of group II, in 20 interdental spaces (9.0 % of the examined number) with completely absent interdental gingival papillae (PIS index – 0 degree) in the area of the contact surfaces of the lateral

teeth, the average value of the contact-alveolar height was 7.1 ± 0.2 mm, this indicator was also significantly ($p < 0.05$) the highest, in 69 interdental spaces (30.8 %) with fully preserved gingival papillae (PIS index – 3 degree) the contact-alveolar height was the lowest ($p < 0.05$) and amounted to 2.8 ± 0.1 mm.

Regarding the cervical proximal index in patients of group I in the area of contact surfaces of the posterior teeth with carious lesions and restorations, in 82 interdental spaces (23.5 %) with complete loss of gingival papillae (PIS index – 0 degree), the average cervical proximal index was 3.0 ± 0.1 mm. This is significantly ($p < 0.05$) the highest index in this group, it is 4.3 times ($p < 0.05$) higher than that determined in 55 interdental spaces (15.7 %) with fully preserved interdental gingival papillae (PIS index – 3 degree) and was equal to 0.7 ± 0.1 mm. In 20 interdental spaces (9.0 %), in which interdental gingival papillae were absent (PIS index – 0 degree), in the area of the lateral teeth with intact contact surfaces of the examined persons of group II, the cervical-proximal index was 3.4 ± 0.2 mm, which is also significantly ($p < 0, 05$) the highest value in patients of this group, while with complete preservation of the gingival papillae (PIS index – 3 degree) in 69 interdental spaces (30.8 %), the cervical-proximal index was 4.9 times ($p < 0.05$) lower, amounting to 0.7 ± 0.1 mm, as in group I.

To predict the probability of preservation or restoration of interdental gingival papillae in the treatment of caries of the contact surfaces of the posterior teeth in patients with generalised periodontitis of the initial and initial – I degree, the software complex “Papillary Expert” was developed.

A

B

Fig. 2 Screenshot of the “Papillary Expert” program, patient M., 37 years old, stages of the program: A – filling in the windows with data of 6 indices; B – report on the program implementation.

analysing them, an individual prognosis for the preservation or restoration of the interdental gingival papilla in this area was made for each patient using the Papillary Expert software product.

An example of clinical application of the software package “Papillary Expert”. Patient M., 37 years old, objective data of clinical examination: contact-alveolar height – 3.6 mm, width of keratinised gingiva in the study area – 2.4 mm, cervical-proximal index – 1.8 mm, initial degree of resorption of interalveolar septum, thick periodontal biotype.

Based on the clinical examination of the patient, the appropriate parameters for each of the indicators are selected. A table with digital options appears on the monitor screen. It is necessary to select a value that corresponds to the data obtained as a result of measurements of contact-alveolar height, cervical-proximal index, width of keratinised gingiva, determination of periodontal biotype, depth of periodontal pocket, degree of resorption of the apex of the interalveolar septum.

The corresponding columns are filled in sequentially and the examination data of the interdental triangles to be restored are entered (Fig. 2, A, B).

The main task of the software development stage was to determine the information features. Based on the results of clinical studies of the periodontal complex of patients with generalised periodontitis with carious lesions of the posterior teeth, 6 criteria were identified – information signs: the width of the keratinised gums, the value of the contact-alveolar height and the cervical-proximal index, the periodontal biotype, the depth of the periodontal pocket and the degree of resorption of the interalveolar bone. As an indicator of the success of the treatment of carious lesions of the contact surfaces of the posterior teeth in patients with generalised periodontitis, signs of the presence of a full-volume interdental gingival papilla were used.

The Papillary Expert software package was clinically tested. After entering all the necessary data obtained prior to the restoration of the contact surfaces of the posterior teeth and

After pressing the “Result” button, the monitor screen displays an image of the preliminary diagnosis, the probability of restoring the volume of the interdental gingival papilla in percentage, and a photograph of the teeth before and after restoration.

According to the entered clinical examination data, the Papillary Expert software determined the probability of restoring the interdental gingival papilla in the case of restoration of the contact surfaces of the posterior teeth at the level of 97 %.

Our study demonstrated a high prevalence (82.6 %) of carious lesions on the contact surfaces of posterior teeth in patients aged 18 to 45 with initial and initial-I degree generalized periodontitis, with an intensity index of 14.6 ± 0.2 , indicating a significant correlation between generalized periodontitis and dental caries. These findings align with previous studies that have highlighted the interrelationship between periodontal disease and carious lesions [10, 11]. The significant differences in the width of keratinized gingiva and periodontal biotype, particularly on the upper jaw ($p < 0.05$), between patients with carious lesions/restorations and those with intact contact surfaces suggest that carious involvement may adversely affect periodontal parameters. This observation corroborates the notion that anatomical and topographical changes in the periodontal complex influence the development and progression of periodontal diseases [12]. The contact-alveolar height and the newly proposed cervical-proximal index emerged as the most informative indicators for assessing the state of interdental triangles. Specifically, patients with complete absence of interdental gingival papillae (PIS index – 0 degree) exhibited significantly higher contact-alveolar height (7.6 ± 0.1 mm) and cervical-proximal index (3.0 ± 0.1 mm) compared to those with fully preserved papillae (PIS index – 3 degree), who had values of 3.5 ± 0.1 mm and 0.7 ± 0.1 mm, respectively ($p < 0.05$). This significant correlation underscores the importance of these parameters in predicting the restoration outcomes of interdental papillae. Similar findings have been reported in the literature, emphasizing the role of interdental anatomical factors in periodontal health and the success of restorative procedures [8, 9]. The development and clinical testing of the Papillary Expert software, which utilizes these key indicators, demonstrated a high level of accuracy in predicting the preservation or restoration of interdental gingival papillae post-restoration. The software's ability to provide individualized prognoses can aid clinicians in selecting the most rational tooth filling methods, thereby enhancing the effectiveness of comprehensive treatment for generalized periodontitis. This approach is in line with contemporary trends in utilizing digital technologies to improve diagnostic accuracy and treatment planning in dentistry [1, 12]. The visual demonstration of the software's functionality serves as a convincing tool for dentists, motivating them to adopt evidence-based treatment strategies for restoring caries-affected contact surfaces in patients with generalized periodontitis. By integrating digital assessment tools into clinical practice, practitioners can improve periodontal outcomes and overall oral health. The importance of such technological advancements has been emphasized in recent publications, highlighting the potential of software applications in enhancing patient care [10, 11]. Future research should focus on expanding the application of this software to a broader patient population, including those with varying degrees of periodontal disease severity. Additionally, integrating artificial intelligence and machine learning algorithms could further refine the predictive capabilities of the software, leading to more personalized treatment plans and improved clinical outcomes.

Conclusions

1. In patients aged 18 to 45 with initial and initial-I degree generalized periodontitis, the prevalence of carious lesions on the contact surfaces of posterior teeth was 82.6 %, with an intensity index of 14.6 ± 0.2 , indicating a significant correlation between generalized periodontitis and high caries prevalence.

2. The contact-alveolar height and the newly proposed cervical-proximal index were the most informative indicators for assessing the state of interdental triangles. Patients with complete absence of interdental gingival papillae exhibited significantly higher contact-alveolar height (7.6 ± 0.1 mm) and cervical-proximal index (3.0 ± 0.1 mm) compared to those with fully preserved papillae (3.5 ± 0.1 mm and 0.7 ± 0.1 mm, respectively; $p < 0.05$).

3. The developed software, utilizing these key indicators, provided a high level of accuracy in predicting the preservation or restoration of interdental gingival papillae after restoration of the contact surfaces of posterior teeth in patients with generalized periodontitis, thereby aiding in selecting the most effective treatment strategies.

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PECULIARITIES OF LIPID METABOLISM DISORDERS IN NORMOTENSIVE PERSONS WITH BURDENED HEREDITY FOR HYPERTENSION AND PATIENTS WITH STAGE II HYPERTENSION

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The article presents the results of a study of lipid metabolism in healthy individuals with a burdened heredity for arterial hypertension and patients with stage II hypertension. Lipid metabolism was studied using standard lipidogram parameters, with additional determination of apolipoproteins B100 and A-1 and lipoprotein (a). It was noted that in the blood serum of healthy individuals with a burdened heredity for arterial hypertension, proatherogenic changes in lipid fractions occur, similar to those of patients with stage II hypertension. It is noteworthy that the level of Lp(a) in individuals with a hereditary predisposition to hypertension was 67.0 % higher than in the control group ($p < 0.001$) and almost reached the “critical” level, at which the probability of developing cardiovascular disease increases. However, the levels of apolipoproteins B100 and A-1 in this group did not differ from those of the control group. Thus, our data indicate that people with hereditary hypertension experience unfavorable shifts in the lipid spectrum of the blood even earlier in the onset and development of hypertension, which suggests that they are genetically determined.

Key words: hypertension, genetic predisposition, heredity for hypertension, lipid metabolism disorders, dyslipidemia, lipoprotein (a), apolipoprotein A-1, apolipoprotein B100.

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ОСОБЛИВОСТІ ПОРУШЕНЬ ЛІПІДНОГО ОБМІНУ В ОСІБ ЗІ СПАДКОВІСТЮ ПО АРТЕРІАЛЬНІЙ ГІПЕРТЕНЗІЇ ТА У ХВОРИХ НА ГІПЕРТОНІЧНУ ХВОРОБУ II СТАДІЇ

У статті відображені результати дослідження показників ліпідного обміну у здорових осіб з обтяженою спадковістю по артеріальній гіпертензії та пацієнтів з гіпертонічною хворобою II стадії. Ліпідний обмін вивчали за стандартними показниками ліпідограми з додатковим визначенням аполіпопротеїдів В100 і А-1 та ліпопротеїну (а). Відмічено, що в сироватці крові здорових осіб з обтяженою спадковістю по артеріальній гіпертензії відбуваються проатерогенні зміни в ліпідних фракціях, які є аналогічними показникам хворих на гіпертонічну хворобу II стадії. Звертає увагу, що рівень Лп(а) в осіб зі спадковою схильністю до артеріальній гіпертензії був на 67,0 % вищий за групу контролю ($p < 0,001$) і практично досягав «критичного» рівня, при якому зростає ймовірність розвитку серцево-судинних захворювань. Проте, рівні аполіпопротеїнів В100 і А-1 в цій групі не відрізнялися від показників контролю. Таким чином, отримані нами дані свідчать, що у людей зі спадковістю по артеріальній гіпертензії ще до виникнення і становлення гіпертензії, відбуваються негативні зсуви в ліпідному спектрі крові, що дає підстави думати про їх генетичну обумовленість.

Ключові слова: гіпертонічна хвороба, генетична схильність, спадковість по артеріальній гіпертензії, порушення ліпідного обміну, дисліпідемія, ліпопротеїн (а), аполіпопротеїн А-1, аполіпопротеїн В100.

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Despite the significant scientific advances in modern medicine, cardiovascular disease (CVD) has remained the leading cause of death worldwide including in Ukraine for decades, accounting for more than a third of all deaths, according to WHO [1, 9, 11].