In the context of modern society, which is characterized by the rapid development of technologies and active exchange of information, the importance of maintaining oral hygiene becomes especially relevant as an integral element of general cultural development. Despite the progress in modern dentistry, oral diseases continue to have a significant impact on the quality of life of the population, which emphasizes the need for additional research and improvement of preventive measures [1].

Inadequate oral hygiene is a key factor in the pathogenesis of a wide range of diseases, including caries, periodontitis and gingivitis, causing the development of symptoms from bad breath to pigmentation of hard dental tissues [2].

Care of the oral cavity becomes especially relevant in cases of using dental prostheses structures. The use of specialized materials in the manufacture of orthopedic structures leads to the formation of dental plaque, the intensity of which depends on the characteristics of the surface material. Design features of prostheses, such as retention elements, can prevent effective self-cleaning and require intensification of home care for them to prevent the development of these pathological conditions [3].

Analysis of scientific sources demonstrates that the presence of fixed orthopedic structures in the oral cavity contributes to the growth of microbial contamination and increases the intensity of signs of inflammation [4].

Studies emphasize that the index method of biofilm assessment, which includes the analysis of its structure, component composition, area and mass, is one of the most effective approaches for quantitative assessment of oral hygiene.

Most of the methods allow you to evaluate the hygiene of the oral cavity and the state of orthopedic structures, among which the Green-Vermillion, Silness & Loe indices, the PHI hygiene index of prostheses, the calculus index (Calcus Index) and others stand out. These approaches have their own unique features, but are also accompanied by certain disadvantages that complicate the process of quality assessment of hygiene. Common problems that characterize these indices include the subjectivity of assessments, limitations in the scope of research, complexity and lack of universality. The vast majority of these methods are based on the quantitative assessment of oral hygiene.

In recent years, dental practice has been enriched by the use of innovative luminescent diagnostic technologies, such as Quantitative Light-induced Fluorescence (QLF) and Fluorescent Plaque Index (FPI), which are used to detect dental plaque. These methods are important not only for analyzing the hygienic condition of the oral cavity, but also for identifying the early stages of caries. However, it is noted that they focus mainly on the analysis of the condition of natural teeth, leaving out fixed dentures. In addition, fluorescence techniques have certain disadvantages, including high costs, the duration of diagnostic procedures and the need for specialized training of the doctor. Therefore, the development of a universal fluorescent method for assessing oral hygiene, which would effectively take into account both the surface of natural teeth and fixed structures of dental prostheses, is an urgent need of modern dentistry [8-12].

The aim of the study

The purpose of this study is the development and testing of an improved version of the fluorescent diagnostic technique in the field of orthopedic dentistry. The research is aimed at creating a method that will allow for digital graphic analysis and the development of an evaluation index for the analysis of the hygienic condition of both natural teeth and fixed prosthetic structures.

In particular, this index can be considered as a reliable tool for use in clinical practice, especially for orthopedic doctors, which will contribute to improving the quality of diagnosis and treatment of patients.
Materials and methods
The proposed technique was based on the staining of the vestibular surface of fixed structures of dental prostheses and the surface of natural teeth, which showed its visibility only under the influence of ultraviolet (UV) light, for the detection of which Rhodamine G dye was used.

This technique was aimed at determining the area of dental plaque on the surfaces of fixed prostheses and the enamel of natural teeth, which made it possible to further analyze the quality and quantity of dental deposits and evaluate the oral hygiene index.

Rhodamine G is a fluorescent dye that shows its activity under the influence of ultraviolet radiation. When deepening UV rays, rhodamine responds by emitting ultraviolet light.

The procedure for performing the method involved diluting powdered rhodamine G in water at a ratio of 0.1 g per 100 ml of water. The resulting solution was applied to the vestibular surface of the teeth or fixed prosthesis with the help of a brush or a cotton ball, after which the treated area was exposed to ultraviolet rays in a darkened room. A Wood's LW702 ultraviolet lamp was used to activate the fluorescent properties of Rhodamine G.

During the study of the effect of ultraviolet radiation on the vestibular surface of the teeth, photofixation of dental plaque was carried out. The obtained images were processed using the program Image J version 1.54d., (National institutes of health, USA) with an open license. The image processing process involved conversion to 8-bit format, after which the necessary areas for research were selected using Lasso or Brush tools. Then, using the Threshold function, color areas were selected. In the Analyze section, the Set measure parameters were set, which included the area (Area), the percentage of the area (Area fraction), the perimeter (Perimeter) and the Display label indicator, which indicated the name of the image. The final stage was the use of the Measure function to obtain data on the specified parameters and determine the percentage of colored plaque relative to the total area of the analyzed area [13, 14, 15, 16].

Research results
In an in vivo experiment on a volunteer, the hygienic condition of the surface of a fixed bridge-like prosthesis in the frontal area of the teeth of the upper jaw and the hygienic condition of natural teeth in the frontal area of the lower jaw were analyzed using the above method (Fig. 1).

As part of our study, the luminescence method was used to evaluate a metal-ceramic bridge prosthesis, during which the presence of dental deposits on its surface was identified. Graphic software analysis indicated that the hygienic index of the prosthesis is 10.1% of the entire studied area. The concentration of most deposits in the proximal zones of the structure is significant, which indicates areas with increased retention and may be related to the peculiarities of the anatomical structure of the bridge prosthesis (Fig. 2).

Fig. 1. Visualization of dental deposits under UV irradiation

Fig. 2. Evaluation of the metal-ceramic structure in the ImageJ program

Fig. 3. Evaluation of natural teeth in the ImageJ program

Compared to a fixed bridge prosthesis, the analysis of the surface of natural teeth revealed an almost double deterioration of the hygienic condition, quantified as 19.3% of the total examined area. The largest places of localization of dental plaque were found in the cervical area and in places where the integrity of the tooth structure was violated, this fact may be due to the greater roughness of the enamel of natural teeth, which contributes to the increased adhesion of microorganisms, compared to the smoother and less reining surface of metal-ceramic structures, which in its turn is the result of their production technology (Fig. 3).

Conclusion
The conducted clinical experiment demonstrated the effectiveness of the improved method of fluorescent determination of hygiene, both on the
enamel surface of natural teeth and on the ceramic surface of fixed orthopedic structures in clinical conditions. It is also worth noting that the proposed technique is convenient to use, the software is available to a wide range of doctors. The main efforts in the future work will be focused on the development of algorithms for use in the conditions of dental reception, as well as on the determination of numerical indicators that can serve as indicators of the hygienic state, with the aim of creating a special coefficient.

Prospects of research

The need for further research is urgent to increase the number of observations both in vivo and in vitro, to clarify the evaluation criteria and to adapt them to various clinical conditions, which will ultimately increase the effectiveness of treatment.

Authors’ contribution

The authors confirm their contribution to the work as follows: concept and design of the study - Korol D.M., Ramus A.M., Ramus M.O.; data collection - Ramus A.M., Kurylo V.O.; analysis and interpretation of results - Ramus A.M., Korol D.M., Ramus M.O., Kurylo V.O.

All authors reviewed the results and approved the final outcome of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

Reference


16. Запорожченко ІВ, Король ДМ, Зубченко АГ, Крушельницька ІВ, Агурковська ОН, Юсупова НА. Розробка методу для оцінки стійкості фіксованих протезів до атакування бактерій. Стоматологічний альманах. 2024 № 2. Стаття надійшла 18.04.2024 р.

Summary

This study focuses on the critical need for an oral care, especially when using fixed bridge prostheses. The analysis and impact of insufficient care for oral hygiene on the development of dental diseases and the need to develop effective methods for its assessment have been carried out.

The research consists of the improvement of fluorescent diagnostics in orthopedic dentistry, as well as, in the development of an index for the assessment of the hygiene of natural teeth and fixed denture structures based on an in vivo experiment. This aims to improve the diagnosis of the condition of the oral cavity in patients with fixed prostheses, contributing to the improvement of the quality of their orthopedic treatment.

Materials and methods: The use of fluorescent diagnostics with Rhodamine G dye allows to identify the presence of dental deposits under the influence of ultraviolet light. The technique involves treating teeth and dentures with a solution that enhances the visibility of dental plaque under ultraviolet light.

Research results: The obtained research data confirm the high efficiency of the fluorescent technique in the detection of dental deposits, both on natural teeth and on the surfaces of fixed prostheses. Digital analysis allows you to visualize the specific graphic characteristics of the biofilm, which facilitates the adaptation of an individual approach.

Conclusions: The conducted study demonstrates that the improved fluorescent method was extremely effective in determining the state of oral hygiene, effective both for the analysis of natural teeth and fixed prostheses. The proposed method allows you to determine the hygienic condition in detail, makes a significant contribution to the prevention of dental diseases and improves the optimization of medical interventions.

The technique is easy to use, and the corresponding software is available for dentists. Further expansion of observations for the use of this technique in patients with a different orthopedic spectrum of needs is expected.

Key words: prevention of dental diseases, hygiene rating index, fixed dentures, ultraviolet radiation.
ФЛУОРЄСЦЕНТНИЙ МЕТОД ДІАГНОСТИКИ ЯК ІНСТРУМЕНТ КОМПЛЕКСНОЇ ОЦІНКИ ГІГІЄНИ ПРИРОДНИХ ЗУБІВ І НЕЗІННИХ КОНСТРУКЦІЙ ЗУБНИХ ПРОТЕЗІВ

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Резюме
Дане дослідження зосереджується на критичній необхідності догляду за ротовою порожнинною, особливо при користуванні незінними мостоподібними протезами. Проаналізовано вплив недостатнього догляду за гігієною порожнини рота на розвиток стоматологічних захворювань і необхідність розробки ефективних методів для її оцінювання.

Дослідження полягає в удосконаленні флуоресцентної діагностики в ортопедичній стоматології, а також у розробці індексу для оцінки гігієни природних зубів і незінних конструкцій зубних протезів на основі експерименту in vivo. Це має на меті покращення діагностики стану ротової порожнини в пацієнтів із незінними протезами, сприяючи підвищенню якості їх ортопедичного лікування.

Матеріали і методи. Використання флуоресцентної діагностики з барвником «Родамін Ж», що дозволяє ідентифікувати наявність зубних відкладень під впливом ультрафіолетового світла. Методика передбачає обробку зубів і протезів розчином, який підсилює видимість зубного нійту під ультрафіолетовим освітленням.

Результати дослідження. Отримані дані дослідження підтверджують високу ефективність флуоресцентної методики у виявленні зубних відкладень і на природних зубах, і на поверхнях незінних протезів. Цифровий аналіз дозволяє візуалізувати специфічні графічні характеристики біоплівки, що сприяє адаптації індивідуального підходу.

Висновки. Проведене дослідження демонструє, що вдосконалення флуоресцентний метод виявився високоефективним у визначенні стану гігієни ротової порожнини, ефективний для аналізу і природних зубів, і незінних протезів. Запропонований метод дозволяє детально визначити гігієнічний стан, створює вагомий внесок у профілактику стоматологічних захворювань і оптимізує лікувальні втручання. Методика легка в застосуванні, а відповідне програмне забезпечення доступне для лікарів-стоматологів. Передбачається подальше збільшення кількості спостережень задля розширення можливостей використання цієї методики в пацієнтів ортопедичного профілю.

Ключові слова: профілактика стоматологічних захворювань, індекс оцінювання гігієни, незінні зубні протези, ультрафіолетове опромінення.