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"EFFECTIVENESS OF SPLINTING STRUCTURES MADE OF THERMOPLASTIC POLYMERS AND COBALT-CHROMIUM ALLOY IN THE TREATMENT OF PERIODONTAL DISEASES"

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Abstract:

The article is devoted to the study of the mechanical properties and effectiveness of splinting structures made of the thermoplastic polymer Vitacryl and cobalt-chromium alloy in the treatment of periodontitis. A biomechanical analysis was carried out, including the simulation of masticatory load on the dentition using CBCT data from patients with chronic generalized periodontitis. The results showed that Vitacryl splints provide an optimal tooth displacement amplitude (no more than 9 μm), evenly distributing the load along the dental arch. At the same time, structures made of cobalt-chromium alloy demonstrate a more rigid fixation (amplitude of 3–5 μm) and are suitable for severe forms of periodontitis. Both materials exhibited satisfactory stress-strain properties, confirming their suitability for clinical use.

Keywords: Periodontitis, splinting structures, Vitacryl, cobalt-chromium alloy, biomechanical analysis, masticatory load

INTRODUCTION

The relevance of these developed methodological recommendations lies in the need to increase the effectiveness of periodontitis treatment using modern materials such as thermoplastic polymers and cobalt-chromium alloys [1,4]. Periodontal diseases are a widespread problem in dentistry that requires a comprehensive approach and the use of innovative technologies. Given the increasing number of cases of periodontal diseases, the use of splinting structures made from high-quality materials can significantly improve treatment outcomes and patients' quality of life [2,3,5].Modern methods of periodontitis treatment must take into account the individual needs of patients and the mechanical properties of various materials, making it possible to adapt treatment methods to specific clinical situations. The introduction of thermoplastic polymers such as Vitacryl into clinical practice opens up new opportunities for creating effective splinting structures that improve the functional state of the dentoalveolar system [6,7].It should also be noted that the use of such materials not only contributes to tooth stability and reduces the risk of tissue trauma but also provides more comfortable treatment for patients. In this regard, the development of practical recommendations for dentists that take into account the latest advances in materials science and biomechanics is an urgent task for improving the quality of dental care

Thus, the need to develop and implement methodological recommendations is due to the growing demand for effective and safe methods of treating periodontal diseases, which improves clinical outcomes, reduces financial costs, and enhances patients' quality of life.

MATERIALS AND METHODS

Using experimental studies, a virtual model of the dentition and the upper and lower jaws was created. The model was built based on computed tomography (CBCT) data from patients with mild to moderate chronic generalized periodontitis. Using Vital Engineering, a virtual model of the jaws with various splinting orthopedic structures was created, and various materials used for manufacturing dental prostheses were compared for this purpose. Masticatory load was taken into account. Three variants were modeled for the calculations:

1. Author's splint made of thermoplastic material.
2. Traditional splint made of cobalt-chromium alloy.
3. Control variant – without a splinting structure.

The methodological basis of the study was the linearized theory of elasticity. The calculations were performed for teeth fixed in the mandible at the initial stage of periodontitis. The system of equations described the mechanical behavior of teeth under masticatory load.

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RESULTS

The results are presented

Thus, the data in the table confirm that the mechanical properties of different materials vary, making it possible to select the most suitable material for splinting structures depending on the clinical situation.

Maximum values of stress, strain, and displacement in the studied area.

Tooth displacement when using splinting structures is reduced, especially with the use of cobalt-chromium alloy (CCA), which indicates more stable tooth fixation and a lower degree of mobility. The use of the author's therapeutic and prophylactic splint, manufactured by injection molding from the thermoplastic material Vitacryl, reduces tooth displacement under load, providing a displacement amplitude within the normal range (no more than 10 μm), and distributes the masticatory load evenly along the entire dental arch, thereby reducing pressure on the alveolar part of the mandible, which serves as a supporting zone for the teeth during chewing. When using a traditional splint based on cobalt-chromium alloy, displacement is limited to the range of 4–6 μm, providing a more rigid fixation. The thermoplastic material in the splint also effectively reduces the amplitude of physiological displacements, ensuring the stability and functionality of the structure.The results showed that the stress-strain state of the model, which includes teeth, the mandibular body with periodontium, and splinting structures made of thermoplastic material and cobalt-chromium alloy, is within normal limits for both materials.The zone of maximum stress is concentrated at the point of contact between the teeth and the splint and is evenly distributed along the entire dentition, indicating the importance of using splinting structures to reduce load and improve tooth stability in periodontal diseases. The data confirm that both Vitacryl and cobalt-chromium alloy are suitable for manufacturing splinting structures for the treatment of periodontal diseases.

CONCLUSIONS

Tooth stability and reduction of tissue trauma risk can be achieved using orthopedic splinting prostheses made of the polymer material Vitacryl. They account for the increased distributed load on the dentition during functional activity, which leads to excessive pressure on the alveolar process of the mandible.

Effectiveness of polymer and metal splints: Splints made of the thermoplastic material Vitacryl reduce the amplitude of physiological tooth displacement to standard values (no more than 9 μm), ensuring stability in moderate forms of mobility. At the same time, traditional structures based on cobalt-chromium alloy (CCA) provide a more rigid fixation with a displacement amplitude in the range of 3–5 μm, making them preferable for the treatment of complex forms of periodontitis.Functional properties of materials: The results of the biomechanical analysis showed that the stresses and strains in the studied structures made of Vitacryl and CCA are within acceptable strength limits, confirming their suitability for long-term use in clinical practice.

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