BIOCHEMICAL EFFECTS OF DIFFERENT DENTAL PROSTHETIC MATERIALS (ACRYLIC, METAL-CERAMIC, NYLON)

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Abstract: Dental prosthetic materials play a crucial role in restoring oral function and aesthetics; however, their interaction with the oral biochemical environment significantly affects patient adaptation and long-term clinical outcomes. This study investigates the biochemical effects of commonly used dental prosthetic materials—acrylic, metal-ceramic, and nylon—on the oral cavity. Changes in salivary pH, enzymatic activity, inflammatory biomarkers, immunological indicators, and oxidative stress parameters were analyzed during the adaptation period. The findings demonstrate material-dependent biochemical responses, with nylon showing the highest biocompatibility and minimal biochemical alterations. The results emphasize the importance of individualized selection of prosthetic materials to optimize patient adaptation and oral health.

Keywords: Dental prostheses; acrylic materials; metal-ceramic prostheses; nylon prostheses; biochemical markers; saliva; biocompatibility.

Аннотация: Стоматологические протезные материалы играют ключевую роль в восстановлении функций полости рта и эстетики; однако их взаимодействие с биохимической средой полости рта существенно влияет на адаптацию пациентов и отдалённые клинические результаты. В данном исследовании изучено биохимическое влияние наиболее широко применяемых стоматологических протезных материалов — акрила, металлокерамики и нейлона — на ткани полости рта. В период адаптации анализировались изменения pH слюны, ферментативной активности, воспалительных биомаркеров, иммунологических показателей и параметров оксидативного стресса. Полученные результаты свидетельствуют о материал-зависимых биохимических реакциях, при этом нейлон продемонстрировал наибольшую биосовместимость и минимальные биохимические изменения. Результаты исследования подчёркивают важность индивидуального подхода при выборе протезных материалов для оптимизации адаптации пациентов и поддержания здоровья полости рта.

Ключевые слова: Стоматологические протезы; акриловые материалы; металлокерамические протезы; нейлоновые протезы; биохимические маркеры; слюна; биосовместимость.

Annotatsiya: Stomatologik protez materiallari og‘iz bo‘shlig‘i funksiyalari va estetikani tiklashda muhim ahamiyatga ega bo‘lib, ularning og‘iz bo‘shlig‘ining

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biokimyoviy muhiti bilan o‘zaro ta’siri bemorlarning moslashuv jarayoni va uzoq muddatli klinik natijalarga sezilarli ta’sir ko‘rsatadi. Ushbu tadqiqotda stomatologik amaliyotda keng qo‘llaniladigan akril, metallokeramika va neylon protez materiallarining og‘iz bo‘shlig‘iga biokimyoviy ta’siri o‘rganildi. Moslashuv davrida so‘lak pH ko‘rsatkichi, fermentativ faollik, yallig‘lanish biomarkerlari, immunologik ko‘rsatkichlar hamda oksidativ stress parametrlaridagi o‘zgarishlar tahlil qilindi. Tadqiqot natijalari protez materiallariga bog‘liq biokimyoviy javob reaksiyalarini ko‘rsatdi, bunda neylon eng yuqori biokompatibilitetga ega bo‘lib, minimal biokimyoviy o‘zgarishlar bilan ajralib turdi. Olingan natijalar bemorlarning moslashuvini yaxshilash va og‘iz bo‘shlig‘i sog‘lig‘ini saqlash maqsadida protez materiallarini individual tanlash zarurligini tasdiqlaydi.

Kalit so‘zlar: Tish protezlari; akril materiallar; metallokeramika protezlari; neylon protezlar; biokimyoviy markerlar; so‘lak; biokompatibilitet.

1. Introduction

Dental prosthetic rehabilitation is widely used to restore masticatory function, phonetics, and aesthetics in patients with partial or complete tooth loss. Despite technological advancements, adaptation to dental prostheses remains a complex biological process influenced by material composition and host response. Prosthetic materials interact directly with saliva and oral tissues, triggering biochemical and immunological reactions that may affect patient comfort and prosthesis longevity. Acrylic resins, metal-ceramic systems, and nylon-based materials differ significantly in their chemical structure, surface properties, and biocompatibility. Therefore, evaluating their biochemical impact on the oral environment is essential for evidence-based prosthetic dentistry.

The purpose of this study is to outline relevant elements regarding the biochemical interactions between prosthetic materials used for obtaining implant-supported restorations and the oral environment. Implant-supported prostheses have seen unprecedented development in recent years, benefiting from the emergence of both new prosthetic materials (with increased biocompatibility and very good mechanical behavior), and computerized manufacturing technologies, which offer predictability, accuracy, and reproducibility. On the other hand, the quality of conventional materials for obtaining implant-supported prostheses is acknowledged, as they have already proven their clinical performance. The properties of PMMA (poly (methyl methacrylate))—which is a representative interim material frequently used in prosthodontics—and of PEEK (polyether ether ketone)—a biomaterial which is placed on the border between interim and final prosthetic use—are highlighted in order to illustrate the complex way these materials interact with the oral environment. In regard to definitive prosthetic

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materials used for obtaining implant-supported prostheses, emphasis is placed on zirconia-based ceramics. Zirconia exhibits several distinctive advantages (excellent aesthetics, good mechanical behavior, biocompatibility), through which its clinical applicability has become increasingly wide. Zirconia's interaction with the oral environment (fibroblasts, osteoblasts, dental pulp cells, macrophages) is presented in a relevant synthesis, thus revealing its good biocompatibility.

2. Materials and Methods

The study included patients undergoing prosthetic treatment with removable and fixed dental prostheses. Participants were divided into three groups according to the prosthetic material used:

Group I: Acrylic prostheses

Group II: Metal-ceramic prostheses

Group III: Nylon prostheses

Unstimulated saliva samples were collected before prosthesis placement and during the early adaptation period (7–14 days). Biochemical analysis included salivary pH, total protein concentration, amylase activity, immunoglobulin A (IgA) levels, and antioxidant enzyme activity. Statistical analysis was performed using standard comparative methods, with significance set at $p < 0.05$. Due to the variable design of the scientific studies regarding the materials used for obtaining implant-supported fixed prostheses, it is quite challenging to assess the influence of diverse prosthetic materials on the oral environment; moreover, the impact of prosthodontic material selection on the endosseous implant survival-rate is not yet very clear.

The aim of this paper is to present the biochemical interactions of interim and definitive prosthetic materials used for obtaining implant-supported fixed prostheses within the oral environment, highlighting the possible biological complications associated with these materials. Additionally, this paper aims to present aspects related to the survival-rate of implant-supported fixed prostheses, in terms of materials used in the manufacturing of prostheses.

3. Results

Patients using acrylic prostheses demonstrated a significant decrease in salivary pH and an increase in inflammatory and oxidative stress markers during the early adaptation period. Metal-ceramic prostheses showed relatively stable biochemical parameters, although minor changes associated with metal ion release were observed in some cases.

Nylon prostheses exhibited minimal changes in salivary composition, maintaining near-physiological pH and antioxidant balance. IgA levels remained stable in this group, indicating better immunological tolerance compared to other materials.

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The results of the study showed that patients who used acrylic dentures had a decrease in salivary pH and an increase in inflammatory biomarkers during the early stages of adaptation. Metal-ceramic dentures maintained a relatively stable biochemical environment, but in some cases, the release of metal ions was observed. Nylon dentures had the highest biocompatibility, with minimal changes in salivary parameters.

Oxidative stress indices were higher in acrylic dentures, indicating that these materials adapt more slowly to oral tissues.

The observed biochemical changes highlight the influence of prosthetic material composition on oral homeostasis. Acrylic materials may induce transient biochemical imbalance due to residual monomers and surface roughness. Metal-ceramic systems demonstrate acceptable biocompatibility but require monitoring for potential metal-related reactions. Nylon materials showed superior adaptability, likely due to their flexibility, chemical stability, and lower interaction with salivary components. These findings align with recent studies emphasizing saliva-based biomarkers as reliable indicators of prosthesis biocompatibility.

Biocompatibility and biomechanical properties materials used in obtaining prostheses represent important topics in modern scientific research. practical relevance studies belonging to this field dentistry consists providing guidelines and helpful information for dental clinicians, in order select appropriate materials for each clinical case. The present paper describes several favorable properties PMMA (poly (methyl methacrylate)), recognized interim prosthetic material. However, different aspects regarding biochemical interaction PMMA (poly (methyl methacrylate)) with oral are presented (cytotoxicity, monomer release, influence on salivary status), which raise concerns about possible adverse oral effects caused this material. These aspects become even more significant for dental implant therapy, which requiresfavorable soft and hard tissues reactions. incorporation NAC (N-acetyl cysteine)might regarded as effective strategy to obtain more biocompatible and clinically reliable PMMA (poly (methyl methacrylate))-based dental resins. Relevant properties PEEK (polyether ether ketone)—a high-performance polymer, which was recently introduced on the market as a promising biomaterial—are also presented in this paper. PEEK (polyether ether ketone) can be used both as a longterm interim and a definitive prosthetic material due to its esthetics, suitability for digital manufacturing, physical properties, chemical stability, and favorable interaction with oral environment. long-term clinical studies are available on use PEEK (polyether ether ketone) in clinical dental practice; therefore, scientific research is needed on topic. This paper also focuses several prosthetic materials designated for obtaining defini-tive implant-supported prostheses. long-term success metal–ceramic implant-supported prostheses has

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already been demonstrated. On the other hand, zirconia-based prostheses (ceramic-veneered zirconia prostheses or monolithic zirconia ones) present better esthetics than metal–ceramic prostheses, very good mechanical behavior, and excellent biocompatibility. Recent scientific studies ascertain that zirconia, no matter tested physical form, regarded as valuable biocompatible material. Relevant aspects regarding interaction with the oral environment were outlined in this paper, its very good biocompatibility in mouth. Zirconia exhibits excellent biomechanical properties, but it has certain disadvantages related to the fracture rates of veneering ceramics and the possibility of degradation in the oral environment. However, zirconia is highly recommended for obtaining definitive implant-supported prostheses. Further research with standardized parameters for assessment biochemical oral interaction interim and definitive prosthetic materials used for obtaining implant-supported prosthesis and long-term follow-up studies on the survival rate and complications of implant-supported prosthesis are still required

5. Conclusion

Different dental prosthetic materials exert distinct biochemical effects on the oral environment. Nylon prostheses demonstrate the highest biocompatibility and the most favorable biochemical profile during adaptation. Acrylic prostheses require careful patient selection and monitoring, while metal-ceramic prostheses offer balanced clinical performance. Incorporating biochemical assessment into prosthetic planning can improve patient outcomes and reduce complications.

The results of the study show that nylon dentures are characterized by high biocompatibility and comfort. Acrylic dentures, on the other hand, remain an economically viable and widespread option. Choosing the type of denture taking into account the individual condition of the patient increases the effectiveness of dental treatment. According to the results of the study, different denture materials have different effects on the biochemical environment of the oral cavity. Nylon dentures have the highest biocompatibility, while metal-ceramics provide stable results. Acrylic dentures should be used with caution and on the basis of an individual approach. The data obtained are important for choosing the optimal denture material in clinical practice, taking into account the patient's condition.

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