UDC 616.314-77:615.461 https://doi.org/10.26641/2307-0404.2024.2.307464

Yu.I. Poliukhovych,
A.Ye. Demkovych *,
Yu.I. Bondarenko,
V.V. Shcherba,
O.I. Lebid,
K.M. Duda

CHARACTERISTICS OF BASE MATERIALS AND ACRYLATES USED IN REMOVABLE PROSTHETICS IN DENTAL PRACTICE (review)

I. Horbachevsky Ternopil National Medical University
Maidan Voli, 1, Ternopil, 46001, Ukraine
Тернопільський національний медичний університет імені І.Я. Горбачевського МОЗ України
майдан Волі, 1, Тернопіль, 46001, Україна
**e-mail: demkovushae@tdmu.edu.ua*

Цитування: Медичні перспективи. 2024. Т. 29, № 2. С. 18-26
Cited: Medicni perspektivi. 2024;29(2):18-26

Key words: *removable prosthesis, base materials, acrylic plastic, mucous membrane, material science, stomatitis, adaptation*
Ключові слова: *знімний протез, базисні матеріали, акрилова пластмаса, слизова оболонка, матеріалознавство, стоматит, адаптація*

Abstract. Characteristics of base materials and acrylates used in removable prosthetics in dental practice (review). Poliukhovych Yu.I., Demkovych A.Ye., Bondarenko Yu.I., Shcherba V.V., Lebid O.I., Duda K.M. *One of the actual problems of modern orthopedic dentistry is the development of optimal materials that, by their physical and chemical properties, would be most biocompatible with the mucous membrane of the oral cavity. The purpose of this work was to substantiate the use of base materials and acrylates for the manufacture of removable prostheses and to increase the effectiveness of orthopedic treatment of patients with complete or partial absence of teeth basing on the review of literary sources. A literature review was conducted using PubMed, Web of Science, SCOPUS, Google Scholar from 2019 to January 2024. There was no restriction on the date of publication or language. Searches were conducted according to MeSH (Medical Subject Headings) using the following search terms: "removable prosthetics", "removable prostheses", "dental base materials", "acrylates", "materials science", "adaptation". A total of 82 sources of literature were selected and processed during the primary analysis. After systematization of the selected information using general scientific methods, 70 most relevant sources remained. Exclusion criteria: publications that did not meet the purpose of this review, publication language other than English and Ukrainian. Used methods: bibliographic and analytical. The relation between the properties of the materials from which the prosthesis is made and the mucous membrane of the prosthetic bed was revealed, and the direct dependence of the quality of the prosthesis, the period of wearing, and the level of oral hygiene was determined. The base material must be easy to use so that the prosthesis can be manufactured and repaired without the use of a significant number of technological processes and equipment. The most common and popular material for manufacturing the bases of partial and complete removable prostheses are acrylates due to their low cost and the simplicity of the application technology, which does not require expensive equipment. The analysis of these literature sources showed that the percentage ratio of the composition of removable prostheses, which includes acrylic plastic, is more than 80%. However, except all existing advantages, they have a number of disadvantages. The main unsatisfactory quality of acrylic prostheses is their negative impact on the tissues of the prosthetic bed, which is reflected in the sensitivity of the mucous membrane and the phenomena of inflammation. Most often, this is manifested as a result of the reproduction of pathogenic microflora, which is concentrated on the surface of the base of the prosthesis. It is worth remembering that removable prostheses are inherently combined irritants that have a whole set of negative effects on the mucous membrane of the prosthetic bed, leading to its chronic inflammation. The above-described negative properties of acrylic plastic became the impetus for the creation of other types of materials. This problem is extremely urgent, and despite the serious resources spent on its elimination, so far no optimal way to increase not only the functionality and durability of the service, but also the safety of using removable orthopedic constructions has been found.*

Реферат. Характеристика базисних матеріалів та акрилатів, які використовуються при знімному протезуванні в стоматологічній практиці (огляд літератури). Полюхович Ю.І., Демкович А.Є., Бондаренко Ю.І., Щерба В.В., Лебідь О.І., Дуда К.М. *Однією з актуальних проблем сучасної ортопедичної стоматології є розробка оптимальних матеріалів, які за своїми фізичними та хімічними властивостями були б максимально біосумісні зі слизовою оболонкою порожнини рота. Метою цієї роботи було обґрунтувати на основі огляду літературних джерел застосування базисних матеріалів та акрилатів для виготовлення знімних протезів і підвищення ефективності ортопедичного лікування пацієнтів з повною або частковою відсутністю*

зубів. Огляд літератури проводився за допомогою PubMed, Web of Science, SCOPUS, Google Scholar з 2019 року до січня 2024 року. Не було обмежень щодо дати публікації чи мови наукових джерел. Пошуки проводилися за термінами MeSH (Medical Subject Headings) з використанням таких пошукових термінів: «знімне протезування», «знімні протези», «стоматологічні базисні матеріали», «акрилати», «матеріалознавство», «адаптація». Усього при первинному аналізі було відібрано та опрацьовано 82 джерела літератури. Після систематизації відібраної інформації за допомогою загальнонаукових методів залишилось 70 найбільш релевантних джерел. Критеріями виключення були публікації, які не відповідали меті цього огляду, мова публікації, крім англійської та української. Використані методи: бібліографічний та аналітичний. Виявлено взаємозв'язок між властивостями матеріалів, з яких виготовлено протез, та слизовою оболонкою протезного ложа, визначено пряму залежність якості виготовлення протеза, термінів носіння, рівня гігієни ротової порожнини. Базисний матеріал повинен бути простим у застосуванні, щоб можна було виготовити та полагодити протез без використання значної кількості технологічних процесів та устаткування. Найбільш поширеним та затребуваним матеріалом для виготовлення базисів часткових та повних знімних зубних протезів є акрилати, завдяки своїй низькій собівартості і простоті технології застосування, яка не вимагає дорогого обладнання. Аналіз даних джерел літератури показав, що відсоткове співвідношення складу знімних протезів, куди входить акрилова пластмаса, становить понад 80%. Однак за всіх існуючих переваг у них є і цілий ряд недоліків. Головною незадовільною якістю акрилових протезів є їх негативний вплив на тканини протезного ложа, що проявляється в чутливості слизової оболонки та явищами запалення. Найчастіше це відбувається внаслідок розмноження патогенної мікрофлори, яка сконцентрована на поверхні базису протеза. Варто пам'ятати, що знімні протези за своєю суттю є комбінованими подразниками, які мають цілий комплекс негативних впливів на слизову оболонку протезного ложа, що призводять до виникнення її хронічного запалення. Вищеописані негативні властивості акрилової пластмаси стали поштовхом до створення інших видів матеріалів. Ця проблема є надзвичайно актуальною, і, незважаючи на серйозні ресурси, витрачені на її усунення, дотепер так і не виявлено оптимального способу підвищити не тільки функціональність та довговічність служби, а й безпеку використання знімних ортопедичних конструкцій.

One of the most important tasks of modern dentistry is orthopedic rehabilitation of patients suffering from partial or complete absence of teeth [1, 2]. Currently, due to the increase in the average life expectancy, the need for the manufacture of dental prostheses is constantly increasing [3]. Increased requirements for aesthetics, restoration of mastication, speech, diction, emotional stability in patients, growing allergization of the population, fast adaptation time, comfort when using prosthesis, dictate the search for new materials with optimal properties [4, 5, 6, 7, 8]. In connection with this, the relevance of choosing modern designs of removable prostheses that meet clinical and individual requirements is beyond doubt [9, 10, 11]. At the current stage of development of orthopedic dentistry, the requirements for materials used for the manufacture of removable dental prostheses, including base materials, have increased significantly. The quality of these materials determines their functional efficiency and biocompatibility [12, 13]. Improvement of the quality of basic materials is carried out with the help of the following measures: modification of acrylic by the method of copolymerization; improvement of technology of laboratory production of prostheses; development of new materials for use in the field of orthopedic dentistry [14, 15]. The experience of practicing dentists and the results of scientific research confirm that the success of dental orthopedic treatment is determined by the properties of the materials used in the conditions of the oral cavity and under the action of chewing pressure forces [16]. The range of plastics on the dental market is quite diverse, but at the present time, as before, the issues of biocompatibility of these materials remain relevant, which implies the absence of toxic, immunogenic, mutagenic and carcinogenic effects on the human body as a whole [17, 18, 19] and negative effects on tissues prosthetic bed [20, 21]. That is why the research and improvement of the characteristics of basic materials, and in particular acrylates, used in the manufacture of removable orthopedic structures is extremely relevant and is of great importance for the development of modern science.

The purpose of this work was to substantiate the use of base materials and acrylates for the manufacture of removable prostheses and to improve the effectiveness of orthopedic treatment of patients with complete or partial absence of teeth basing on the review of literary sources.

MATERIALS AND METHODS OF RESEARCH

The literature review is based on the analysis of a significant volume of digital publications, which were found as a result of a literature search on global databases, such as PubMed (https://pubmed.ncbi.nlm.nih.gov), Web of Science Core Collection (https://www.webofscience.com/wos/woscc/basic-search), Scopus (https://www.scopus.com) and Google Scholar (https://scholar.google.com.ua). The

review of literary sources was conducted in order to identify and process publications in which the characteristics of basic plastics and the influence of orthopedic structures made of various materials, in particular acrylates, on the organs and tissues of the oral cavity, as well as the significance of changes in the homeostasis of the organism as a whole for adaptation to dental prostheses, were investigated. The literature review covered the period from 2019 to January 2024 to analyze the most recent evidence. Searches were conducted using MeSH terms (Medical Subject Headings) using synonyms and combinations of the following search terms: "removable prosthetics", "removable prostheses", "dental base materials", "acrylates", "materials science", "adaptation". In addition to the electronic search, a similar search in the bibliographic references of the selected articles was performed. A total of 82 sources of literature were selected and processed during the primary analysis, which included evidence-based randomized trials, systematic reviews, and others. After further systematization of the selected information using general scientific methods (analysis, synthesis, generalization, critical evaluation of the collected data), 70 most relevant sources remained. Exclusion criteria: publications that did not meet the purpose of this review, results, publication language other than English and Ukrainian. Methods used for design and writing of the article: bibliographic and analytical. The study was approved by the Bioethics Commission of the Ternopil National Medical University named after I.Ya. Gorbachevskiy of the Ministry of Health of Ukraine (protocol No. 76 dated January 15, 2024).

RESULTS AND DISCUSSION

Since artificial teeth and the base of the prosthesis during chewing are subjected to force loads and to friction, all materials used in orthopedic dentistry for the manufacture of dental prostheses must have high strength – the ability to withstand the action of mechanical forces that cause deformation or destruction of the material [22].

The most common methods of research of strength are testing for stretching, compression, impact, bending, and twisting [23]. One of the important characteristics is hardness (modulus of elasticity) – this is the ability of a material to resist when a harder body is introduced into its surface under the action of a certain force [24]. At the same time, the modulus of elasticity of the material characterizes its wear resistance, that is, the ability to resist abrasion [25]. Another indicator of strength is impact viscosity – this is the ability of a material to stretch under the action of a tension load. Higher indicators of impact viscosity prevent the destruction of prostheses during their use [26].

Plasticity is the ability of a material to change its shape under the influence of a load and not to return to its original state after its termination. The plasticity and mechanical strength of the base material mainly determine the functional qualities and durability of the prosthesis [27].

Since the base of the prosthesis should be as light as possible, the base material should have a low specific gravity. The base material should be chemically inert and insoluble in oral fluid, as the mechanical properties of the material, the stability of the size and shape of the prosthesis largely depend on it [28]. In this regard, important properties of polymer materials are water resistance and water absorption [29], as dental structures are in the moist environment of the oral cavity for a long time. Water resistance is the ability of polymers to retain their properties under the influence of water, which can penetrate through the surface into the depth of the material. Most often, water resistance is characterized by water absorption – the amount of water absorbed by the material in 24 hours of being in water at a temperature of 18-22°C, expressed as a percentage of the sample mass [30]. Such a property as thermal conductivity (the ability of the material to conduct heat) depends on the chemical nature and structure of the polymer matrix, the composition and amount of the filler (plasticizer). Since the thermal conductivity of basic plastics is very low, it is an insulator, which negatively affects the physiology of the oral cavity [31]. With low thermal conductivity of the base plastic, patients using removable prostheses may experience unpleasant sensations under the base of the prosthesis, associated with a violation of temperature perception by the tissues of the prosthetic bed [32].

Along with thermal conductivity, the base material must have thermal resistance to resist distortion due to thermal softening. Despite the fact that the temperature in the oral cavity ranges from 32°C to 37°C, the polymer of the dental prosthesis should have a much higher values of vitrification temperature [33], because it can be exposed to hot drinks with a temperature of up to 70°C. Vitrification temperature is an important key characteristic for polymers, as it determines the range of their use [34].

In recent years, the requirements for the aesthetic properties of the prosthesis have increased significantly [35]. The most important parameter of prosthesis aesthetics is its color [36]. The material of the base in the oral cavity is in contact with various substances with a high ability to coloration. Depending on the degree of water absorption, the adsorption of liquids occurs, which leads to a change

in the initial color, so color stability is one of the most important factors when choosing base materials for dental prostheses [37]. The base material must be easy to use so that the prosthesis can be manufactured and repaired without the use of expensive technological equipment. In addition to the indicators listed above, the choice of material for dental use is determined by such factors as economy and availability [38, 39].

At present, the requirements for the basic materials have increased significantly, and one of the essential problems of modern orthopedic dentistry is the development of optimal materials that, by their physical and chemical properties, are most biocompatible with the mucous membrane of the oral cavity [40].

Base materials are filled materials characterized by the phenomenon of degradation, caused by thermal, mechanical, chemical, photochemical and biological factors. Degradation of plastics leads to wear of prostheses, their fractures, increased fragility, and discoloration. As a result, the physical, mechanical and chemical properties of acrylates change, a break in the chains of macromolecules occurs. At the same time, it is possible for some components to enter the oral cavity [41].

Currently, the market is rich in a huge number of various base materials with various qualities and characteristics [20]. According to literature sources, 85-90% of removable orthopedic structures are made of polymethyl methacrylate copolymers, which have excellent technical properties [42], in particular, they are easily molded into the form of plastic dough, which makes it possible to manufacture these prostheses individually in plaster molds in a water bath, without requiring significant pressure on pressing or temperatures above 100°C; easily dyed in a color imitating the soft tissues of the oral cavity; provide good attachment of artificial acrylic teeth to the base [43].

At the end of the eighteenth century, targeted experiments were conducted in the search for materials for dental structures and devices. At that time, the first prosthesis of porcelain was made by the French apothecary Duchateau. But the porcelain was prone to a lot of shrinkage, which had a negative effect on the compliance of the tissues of the prosthetic bed. In the future, attempts were made to make the base of the dental prosthesis from metals of noble alloys. Prostheses bases were obtained by bending gold plates [10].

In the middle of the 19th century, a method of vulcanizing rubber was discovered, this became a breakthrough in the development of dental prosthetics. A century later, rubber was used as a basis for making removable prostheses. After that, rubber became the main material for the manufacture of bases of removable prostheses [26]. As a result of the successes of the chemical industry, physics and progress in many other branches and spheres of science and technology, appropriate objective conditions for the appearance of more advanced new dental materials have been created. In the 30s of the 20th century, a method of processing acrylic resins in the form of a convenient polymer-monomer composition was invented, this gave rise to the progress of dental prosthetics [37]. Due to their properties, hygiene, and good aesthetic qualities, removable prostheses made of acrylic plastics have become much more functional compared to their precursos.

Until now, acrylic plastics have remained the most common materials for manufacturing the bases of removable prostheses due to their low cost and the simplicity of the application technology, which does not require expensive equipment [44, 45]. The average service life of an acrylic prosthesis is five years. The shortening of the period of effective use of the prosthesis is facilitated by inadequate preparatory measures associated with the lack of sanitation of the oral cavity, ignoring exostoses and bony protrusions, violation of the rules of their use by patients [46].

Acrylates have become widespread since the 1930s, which continues to this day [47]. During this time, many different basic materials appeared, differing from each other in physical and chemical properties and having both advantages and disadvantages. However, the main materials used to create removable prostheses are plastics based on acrylic and methacrylic acid. Analysis of literature sources showed that the ratio of the use of removable prostheses based on acrylic plastic is up to 83% [48].

Modern domestic materials for the manufacturing rigid bases of prostheses are hard plastics: "Ftorax", "Akronil", "Ethacryl", "Stomacryl", "Bacryl" and colorless plastics [49]. "Bacryl" is an acrylic plastic that has excellent resistance to cracking, abrasion, impacts and bending. "Ethacryl" is a material for the bases of prostheses, which is a static tercopolymer of methyl methacrylate, ethyl methacrylate and methyl acrylic ether [50]. Acrylic plastic "Ftorax" is a fluorine-containing acrylic copolymer for the manufacturing of bases of removable prostheses with good physical and mechanical properties: strength, chemical resistance, low water absorption, color and transparency, well imitates the soft tissues of the oral cavity [51].

The physical and mechanical properties of plastics supplied to Ukraine from abroad are comparable to domestic ones. Rigid-based polymers include thermosetting plastics: "Villacryl H Plus", "Villacryl SP", "Futura", "Vertex Implacryl", "Acron MS" [50], etc.

However, as long-term practice shows, although polymers have many advantages, they can have a negative effect on tissues that are in contact with the prosthetic bed and the body as a whole [52, 53]. The main unsatisfactory quality of acrylic prostheses is their negative impact on the tissues of the prosthetic bed. Many patients note impaired sensitivity of the mucous membrane, resulting in inflammatory phenomena [54, 55]. Most often, this is manifested as a result of the reproduction of pathogenic microflora, which is concentrated on the surface of the base of the prosthesis [56]. Microporosity arising in the polymerization process contributes to the formation of space for the reproduction of aerobic microorganisms on the surface of the base and their active contamination. They have a negative effect on the tissues of the prosthetic bed, and subsequently acrylic stomatitis may be diagnosed. The removable orthopedic structure subsequently associates on its surface a dense microbial layer consisting of microorganisms and their metabolites. It contains over 1000 organisms per gram in raw weight and has essentially the same structure as dental plaque on natural teeth [57, 58, 59]. It has been proven that this microbiota causes a disturbance in the balance of the microbiome of the tissues of the oral cavity, at the same time inflammation of the mucous membrane occurs – the so-called "intolerance of plastic prostheses" [60].

Long-term practice of using prostheses made of acrylic polymers has shown that they often lead to the occurrence of intolerance to basic plastics. They have a cytotoxic and sensitizing effect on the mucous membrane of the mouth, which is in direct contact with the base of the prosthesis [47, 61]. One of the main reasons causing these disturbances is the residual monomer, which remains after the polymerization reaction in the amount of up to 7-8% and is released from the base of the prosthesis for several years [62]. The frequency of cases of increased sensitivity to acrylic materials in the bases of prostheses varies from 1% to 13% [63].

The rigidity and porosity of the inner surface of the prosthesis bases can also be the main cause of mechanical trauma to the mucous membrane of the prosthetic bed, especially during rebasing of the base using a cold hardening material [64].

It should be noted that the issue of the strength of this material has not been resolved either, during clinical use due to low static bending strength, insufficient specific viscosity, breakages often occur, this leads to a reduction in service life [65]. The low elasticity of this material affects the difficulty of using it in patients with sharp bony protrusions, a thin mucous membrane of the prosthetic bed and pronounced atrophy of the alveolar ridge [66]. The rigidity and porosity of the inner surface of the prosthesis base are the main causes of mechanical injury to the mucous membrane, especially when reconstructing the base using cold polymerization materials [67]. Also, acrylate polymers have a fairly large shrinkage of 6-8%, due to which there is a mismatch of the inner surface at the base of the prosthesis and the prosthetic bed [68]. The material of the base of the dental prosthesis made of acrylic plastic has a high ability to absorb water and various impurities [69].

The base of a removable orthopedic prosthesis must accurately reproduce the microrelief of the mucous membrane of the tissues of the prosthetic bed. However, during the polymerization of acrylic plastics, linear and volumetric changes due to shrinkage may occur [70]. This can lead to a mismatch between the reliefs of the prosthetic bed and the base of the prosthesis, which in turn can cause uneven distribution of chewing pressure, functional overload and, as a result, breakage of the base of the removable prosthesis [16].

Therefore, the manufacture of removable prostheses, due to the high demand among the population, today, as before, remains a popular and affordable type of orthopedic care.

The analysis of scientific sources of information indicates that even with the improvement of the chemical composition of basic plastics and technologies for manufacturing prostheses, it was not possible to completely eliminate their shortcomings. The main imperfections of partial and full removable prostheses with acrylic bases include the negative effect of excess monomer on areas of the prosthetic bed, adhesion of microorganisms to the plastic due to its porosity, and discoloration over several years of use. However, despite a number of imperfections, acrylic plastics have a simple technology, are economically available, do not require expensive equipment, and therefore are the most common material for manufacturing the bases of removable orthopedic structures. Many authors note that there is no high-quality alternative to acrylic plastic today. No polymer has optimal physico-mechanical, biological and surface characteristics, therefore the search and development of new materials and polymerization methods that eliminate the negative impact of materials on the tissues of the prosthetic bed and increase their mechanical strength remains a promising direction and is one of the most relevant topics in modern orthopedic dentistry.

CONCLUSIONS

1. Successful prosthetics of patients is related to the properties of materials exposed to the oral environment and the action of forces of mastication

load, therefore the issues of biocompatibility and strength of these materials remain relevant.

2. The main materials used to create the bases of removable prostheses are plastics made on the basis of acrylic and methacrylic acid, which are very widely and quickly used in orthopedic dentistry practice.

3. Many years of experience in the use of prostheses made of acrylic polymers have shown that they often lead to phenomena of intolerance to base plastics, causing cytotoxicity and sensitizing during contact with the base, the main cause of which is the presence of residual monomer.

4. The effect of basic materials, in particular acrylates, on the mucous membrane and structures of the oral cavity and on the body as a whole has not been sufficiently studied and requires further research.

Contributors:
Poliukhovych Yu.I. – writing – original draft;
Demkovych A.Ye. – data curation;
Bondarenko Yu.I. – writing – review & editing;
Shcherba V.V. – conceptualization;
Lebid O.I. – resources;
Duda K.M. – methodology.

Funding. This research received no external funding.

Conflict of interests. The authors declare no conflict of interest.

REFERENCES

1. Dobrovolskaya OV. [Dental implantation as a method of optimizing treatment of patients with complete dental teeth]. Ukrainian Dental Almanac. 2019;4:33-40. Ukrainian.
doi: https://doi.org/10.31718/2409-0255.4.2019.06

2. Movchan OV. [Demand in Orthopedic Treatment with Complete Removable Pla stic Prostheses of Kharkiv and Kharkiv Region]. Dentistry news. 2019;1:26-30. Ukrainian. Available from:
https://repo.knmu.edu.ua/bitstream/123456789/23571/1/%d0%9c%d0%9e%d0%92%d0%a7%d0%90%d0%9d_%d0%9d%d0%a1.pdf

3. Messias A, Nicolau P, Guerra F. Different interventions for rehabilitation of the edentulous maxilla with implant-supported prostheses: An overview of systematic reviews. Int J Prosthodont. 2021;34:63-84. doi: https://doi.org/10.11607/ijp.7162

4. Hasiuk P, Kindiy D, Radchuk V, Kindiy V, Demkovych A, Yarkoviy V. Biological compatibility of metal structures of dentures made from multiple melted alloys. Polski Merkuriusz Lekarski. 2022;50(296):114-7. Available from:
http://repository.pdmu.edu.ua/bitstream/123456789/18107/1/Biological_compatibility_of_metal_structures.pdf

5. Carra MC, Rangé H, Swerts PJ, Tuand K, Vandamme K, Bouchard P. Effectiveness of implant-supported fixed partial denture in patients with history of periodontitis: A systematic review and meta-analysis. J Clin Periodontol. 2022 Jun;49(24):208-23.
doi: https://doi.org/10.1111/jcpe.13481

6. Zhou YS, Sun YC, Wang Y. Clinical application and research progress of digitalcomplete denture. Hua Xi Kou Qiang Yi Xue Za Zhi. 2021;39(1):1-8. doi: https://doi.org/10.7518/hxkq.2021.01.001

7. Meira IA, Gama LT, Prado-Tozzi DA, Pinheiro MA, Rodrigues Garcia RCM. Speech in implant-supported and removable complete denture wearers: A systematic review. J Prosthet Dent. 2022;128(6):1230-8. doi: https://doi.org/10.1016/j.prosdent.2021.03.006

8. S'meliak B. [Treatment of Edentulous Maxilla and Mandible Using implant-retained overdentures – Case Reports]. Implantologia, paradontologia, osteologia. 2019;3:27-34. Ukrainian.

9. Goncalves GSY, de Magalhaes KMF, Rocha EP, Dos Santos PH, Assuncao WG. Oralhealth-related quality of life and satisfaction in edentulous patients rehabilitated with implant-supported full dentures all-on-four concept: a systematic review. Clin Oral Investig. 2022;26(1):83-94. doi: https://doi.org/10.1007/s00784-021-04213-y

10. Goldstein G, Kapadia Y, Campbell S. Complete denture occlusion: Best evidence consensus statement. J Prosthodont. 2021;30(s1):72-7.
doi: https://doi.org/10.1111/jopr.13309

11. Araujo R, Zancopé K, Moreira R, Barreto T, Neves F. Mandibular implant-assisted removable partial denture – Kennedy Class I to Class III modification – Case series with masticatory performance and satisfaction evaluation. J Clin Exp Dent. 2023 Jan 1;1(15):71-8. doi: https://doi.org/10.4317/jced.59777

12. Techapiroontong S, Limpuangthip N, Tumrasvin W, Sirotamarat J. The impact ofpoor dental status and removable dental prosthesis quality on body composition, masticatoryperformance and oral health-related quality of life: a cross-sectional study in older adults. BMC Oral Health. 2022;22(1):147.
doi: https://doi.org/10.1186/s12903-022-02103-7

13. Makieiev V, Hunovsky Ya. The features of patient adaptation to removable partial dentures based on the dynamic study of the mucous membrane condition of an oral cavity in the new functioning conditions. Actual Dentistry. 2022;3-4:33-7. Ukrainian.
doi: https://doi.org/10.33295/1992-576X-2022-3-33

14. Sylenko BYu, Dvornyk VM, Sylenko YuI. [The state of tissues of the prosthetic bed inpatients with prosthetic stomatitis during orthopedic treatment withprostheses modified with nanomaterials]. Ukrainian Dental Almanac. 2021;(4):20-5. Ukrainian.
doi: https://doi.org/10.31718/2409-0255.4.2021.04

15. Yanishen IV, Zapara PS, Fedotova OL, Khlistun NL, Saliya LG. Study ofhemodynamics of the mucous membrane of the prosthetic area atthe stages of treatment of patients with removable denturesaccording to the improved technique. Polish Med J. 2022;295:391-5.

16. Khilinich YeS, Nidzelsky MYa, Davydenko VYu, Kuznetsov VV, Davydenko GM. [Techniques to study indicators of temperature in foundation area and pressure onto the mucous membrane from removable laminar dentures]. Actual Problems of the Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy. 2019;4(19):73-6. Ukrainian.
doi: https://doi.org/10.31718/2077-1096.19.4.73

17. Sokolovska VM. [Modern methods to improve biocompatibility of removable dentures by applying ultrasound techniques]. Actual Problems of the Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy. 2020;3(20):73-6. Ukrainian.
doi: https://doi.org/10.31718/2077-1096.20.3.73

18. Demkovych A. Effects of flavonol quercetin on activity of lipid peroxide oxidation in experimental bacterial-immune periodontitis. Interventional Medicine and Applied Science. 2019 Mar;11(1):55-9. doi: https://doi.org/10.1556/1646.10.2018.48

19. Bandrivsky Y, Bandrivska O, Bandrivska N, Bedenyuk O, Kuchyrka L, Zmarko I. Medication correction of themain clinical symptoms of generalized periodontitis in patients with different blood groups. Pharmacia. 2023;70(3):499-507.
doi: https://doi.org/10.3897/pharmacia.70.e102850

20. Sokolova II, Kuznetsov RV, Chulak LD, Kirichek OV, Zverkhanovskyi OA. [Influence of auxiliary groups of materials on productionquality removable orthopedic constructions of dental prosthesis (literature review)]. Experimental and Clinical Medicine. 2023;92(3):1-7. Ukr.
doi: https://doi.org/10.35339/ekm.2023.92.3.skc

21. Matvieienko LM, Matvieienko RY, Fastovets OO. Effects of strontium ranelate on alveolar bone in rats with experimental diabetes mellitus. Wiadomości Lekarskie. 2022;75(1 Pt 2):151-5. Available from: https://repo.dma.dp.ua/7388/1/WLek202201201.pdf

22. Zapara PS. [Comparative evaluation of the quality of the recovery of chewing effectiveness, in the treatment of patients with removable orthopedic dentures made according to various laboratory technologies, based on data electro-myographic research]. Novini Stomatologii. 2019;2:50-4. Ukrainian. Available from: https://repo.knmu.edu.ua/bitstream/123456789/23574/1/%d0%97%d0%90%d0%9f%d0%90%d0%a0%d0%90_%d0%9d%d0%a1.pdf

23. Muluk S, Grover I. Aesthetics of claps in removable partial denture – A literature review. International Journal of Advanced Dental Sciences and Technology. 2023;2(4):1-4.
doi: https://doi.org/10.54105/ijadst.D1009.062422

24. Andrienko K.Y. [Analysis of clinical criteria for assessing quality of removable orthopedic appliances manufactured using doped packaging materials]. Actual Problems of the Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy. 2023;3(3):78-82. Ukrainian. doi: https://doi.org/10.31718/2077-1096.23.3.78

25. Alhallak KR, Nankali A. 3D Printing technologies for removable dentures manufacturing: a review of potentials and challenges. Eur J Prosthodont Restor Dent. 2022 Feb 28;30(1):14-9.
doi: https://doi.org/10.1922/EJPRD_2208Alhallak06

26. Schmutzler A, Rauch A, Nitschke I, Lethaus B, Hahnel S. Cleaning of removable dental prostheses – a systematic review. J Evid Based Dent Pract. 2021 Dec;21(4):101644.
doi: https://doi.org/10.1016/j.jebdp.2021.101644

27. Peng PW, Hsu CY, Huang HY, Chao JC, Lee WF. Trueness of removable partial denture frameworks additively manufactured with selective laser melting. J Prosthet Dent. 2022;127(1):122-7. doi: https://doi.org/10.1016/j.prosdent.2020.06.035

28. Leybuk LV. [Dynamics of rheological properties of oral fluid in the course of their correction in patients with diabetes who use removable complete denture (RCD)]. Actual dentistry. 2020;1:100-2. Ukrainian. doi: https://doi.org/10.33295/1992-576X-2020-1-100

29. Yunizar MF, Watanabe M, Ichikawa T. Current development status of additive manufacturing technologies for fabricating removable partial denture frameworks: a literature review. Int J Comput Dent. 2022;25(1):57-70.

30. Khan AA, Fareed MA, Alshehri AH, Aldegheishem A, Alharthi R, Saadaldin SA, et al. Mechanical properties of the modified denture base materials and polymerization methods: a systematic review. Int J Mol Sci. 2022 May 20;23(10):5737.
doi: https://doi.org/10.3390/ijms23105737

31. Redushko YuV, Dmytryshyn TM, Rozhko OM. [Clinical condition of prosthetic bed tissues in patients who use different adhesive means to improve fixation of removable dentures]. Actual dentistry. 2020;1:96-9. Ukrainian. doi: https://doi.org/10.33295/1992-576X-2020-1-96

32. Ruzuddinov N, Ruzuddinov S, Voronov I, Altynbekov K, Ruzuddinova K. Clinical classification of torus and effectiveness of two-layer bases in removable dentures. J Popul Ther Clin Pharmacol. 2022;29(3):87-93. doi: https://doi.org/10.47750/jptcp.2022.939

33. Hellyer P. Analysis of different workflows for denture construction. Br Dent J. 2022 Aug;233(3):218. doi: https://doi.org/10.1038/s41415-022-4575-1

34. Bechir F, Suciu I. Comparative study of the comfort in patients rehabilitated with three types of partial dentures. Acta Stomatologica Marisiensis. 2019;2(2):223-8. doi: https://doi.org/10.2478/asmj-2019-0010

35. Gama LT, Bezerra AP, Schimmel M, Rodrigues Garcia RCM, de Luca Canto G, Gonçalves TMSV. Clinical performance of polymer frameworks in dental prostheses: A systematic review. J Prosthet Dent. 2022;22:00147-0. doi: https://doi.org/10.1016/j.prosdent.2022.03.002

36. Azmy E, Al-Kholy MRZ, Gad MM, Al-Thobity AM, Emam AM, Helal MA. Influence of different beverages on the color stability of nanocomposite denture base materials. Int J Dent. 2021 Nov 11;2021:5861848. doi: https://doi.org/10.1155/2021/5861848

37. Limpuangthip N, Phuckdeedindan M, Techapiroontong SJ. Clinician evaluation of removable complete denture quality: A systematic review of the criteria and their measu-

rement properties. Prosthet Dent. 2023;0022-3913:00017-3. doi: https://doi.org/10.1016/j.prosdent.2023.01.008

38. Hasiuk P, Kindiy D, Vorobets A, Kindiy V, Demkovych A, Odzhubeiska O. Analysis of the advisability of using different types of base plastics by studying the needs of the population in removable prosthesis. Wiadomosci Lekarskie. 2022;75(12):3055-9. doi: https://doi.org/10.36740/WLek202212128

39. Mukhin ZS, Nikonov AYu, Breslavets NM. [Preventive aspects of modern removable prosthetics]. Problems of uninterrupted medical training and science. 2020;2:76-9. Ukrainian. doi: https://doi.org/10.31071/promedosvity2020.02.076

40. Movchan OV. Orthopedic treatment of patients with edentulous jaws with complete removable plastic dentures using adhesive material. Ukrainian Dental Almanac. 2019;2:34-7. doi: https://doi.org/10.31718/2409-0255.2.2019.07

41. Perea-Lowery L, Minja IK, Lassila L, Ramakrishnaiah R, Vallittu PK. Assessment of CAD-CAM polymers for digitally fabricated complete dentures. J Prosthet Dent. 2021;125(1):175-81. doi: https://doi.org/10.1016/j.prosdent.2019.12.008

42. Lee WF, Wang JC, Hsu CY, Peng PW. Microstructure, mechanical properties, and retentive forces of cobalt-chromium removable partial denture frameworks fabricated by selective laser melting followed by heat treatment. J Prosthet Dent. 2022 Jan;127(1):115-21. doi: https://doi.org/10.1016/j.prosdent.2020.06.038

43. Andrienko KYu, Yanishen IV, Fedotova OL, Pogorila AV, Khlystun NL. [Analysis of interconnection between the base of the removable denture and tissues of the foundation area]. Actual Problems of the Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy. 2023;4(23):284-7. Ukrainian. doi: https://doi.org/10.31718/2077-1096.23.4.284

44. Kostić M, Igić M, Gligorijević N, Nikolić V, Stošić N, Nikolić L. The Use of Acrylate Polymers in Dentistry. Polymers (Basel). 2022;14(21):4511. doi: https://doi.org/10.3390/polym14214511

45. Goswami M, Chauhan N. Prosthetic management with removable partial dentures in pediatric dental care: case series. Int J Clin Pediatr Dent. 2023;16(3):534-40. doi: https://doi.org/10.5005/jp-journals-10005-2593

46. Movchan O, Yanishen I, Diudina I, Tomilin V, German S, Pereshyvailova I. Bacterial contamination and methods of decontamination of bases complete removable prostheses during the application of adhesive. Georgian Med News. 2022;333:61-6. Available from: https://repo.knmu.edu.ua/bitstream/123456789/32185/1/%d0%a1%d1%82%d0%b0%d1%82%d1%8c%d1%8f%20%d0%93%d0%a0%d1%83%d0%b7%d0%b8%d1%8f%202.pdf

47. Costa RTF, Pellizzer EP, Vasconcelos BCDE, Gomes JML, Lemos CAA, de Moraes SLD. Surface roughness of acrylic resins used for denture base after chemical disinfection: A systematic review and meta-analysis. Gerodontology. 2021 Sep;38(3):242-51. doi: https://doi.org/10.1111/ger.12529

48. Joseph A, Mahajan H, Somkuwar K, Yadav NS, Saxena V, Verma V. Analysis of denture base displacement between conventional acrylic removable partial dentures and click fit partials for Kennedy's Class I and II situations: an in vitro study. J Contemp Dent Pract. 2022 Mar 1;23(3):351-4. Available from: https://www.thejcdp.com/doi/JCDP/pdf/10.5005/jp-journals-10024-3324

49. Dvornyk VM, Kuz HM, Tumakova OB, Shemetov OS, Kuz VS. [Results of treatment of edentulous patients with dentures made of «Ftorax»]. Ukrainian Dental Almanac. 2020;1:37-45. Ukrainian. Available from: http://repository.pdmu.edu.ua/bitstream/123456789/12772/1/rezul%ca%b9taty_likuvannya2.pdf

50. Rosolovska SO, Kindiy DD, Hasiuk PA, Kindiy VD, Vorobets AB, Demkovych AYe, et al. Analysis of the influence of basic acrylic plastics "Ftoraks" and "Villacryl H Plus" on the main hematological parameters in the experiment. Clinical dentistry. 2023;42(1):24-9. doi: https://doi.org/10.11603/2311-9624.2023.1.13845

51. Benyahia H, Benaissi A, Bahij L, Merzouk N, Regragui A. Impression techniques in Removable partial denture: epidemiological study. Tunis Med. 2023;1(101);41-6.

52. Alqutaibi AY, Baik A, Almuzaini SA, Farghal AE, Alnazzawi AA, Borzangy S, et al. Polymeric denture base materials: a review. Polymers (Basel). 2023 Jul 31;15(15):3258. doi: https://doi.org/10.3390/polym15153258

53. Alhammadi SH. Full mouth rehabilitation using telescopic removable prosthesis. Case Rep Dent. 2022 Oct 17;2022:9536443. doi: https://doi.org/10.1155/2022/9536443

54. Dolfini Alexandrino L, Martinez Antunes LH, Jardini Munhoz AL, Ricomini Filho AP, da Silva WJ. Mechanical and surface properties of Co-Cr alloy produced by additive manufacturing for removable partial denture frameworks. J Prosthet Dent. 2023 Nov;130(5):780-5. doi: https://doi.org/10.1016/j.prosdent.2021.12.019

55. Hasiuk P, Malko N, Vorobets A, Ivanchyshyn V, Rosolovska S, Korniyenko M, et al. The intensity of chronic catarrhal gingivitis in children depending on the age. Wiadomości Lekarskie. 2020;73(5):846-9. doi: https://doi.org/10.36740/WLek202005102

56. Demkovych A, Kalashnikov D, Hasiuk P, Zubchenko S, Vorobets A. The influence of microbiota on the development and course of inflammatory diseases of periodontal tissues. Frontiers in Oral Health. 2023 Aug 7;4:1237448. doi: https://doi.org/10.3389/froh.2023.1237448

57. Aati S, Aneja S, Kassar M, Leung R, Nguyen A, Tran S, et al. Silver-loaded mesoporous silica nanoparticles enhanced the mechanical and antimicrobial properties of 3D printed denture base resin. J Mech Behav Biomed Mater. 2022;134:105421. doi: https://doi.org/10.1016/j.jmbbm.2022.105421

58. Bandrivsky Yu, Bandrivska O, Bandrivska N, Bedenyuk O, Piasetska L, Dutko K. The effect of complex treatment on some hematological and hemostasiological indicators during the treatment of generalized periodontitis in patients with different blood group affiliation. Pharmacia. 2022;69(4):1027-33. doi: https://doi.org/10.3897/pharmacia.69.e87118

59. Lysokon Y, Bandrivsky YL, Luchynskyi MA. Analysis of the results of treatment of destructive forms of apical periodontitis with osteotropic drugs in a

short term. Wiadomosci lekarskie. 2022;75(1):228-31. doi: https://doi.org/10.36740/WLek202201214

60. AlHamdan EM. Soft Denture liner and microbial disinfection with contemporary and conventional agents. Photodiagnosis Photodyn Ther. 2022 Jun;38:102768. doi: https://doi.org/10.1016/j.pdpdt.2022.102768

61. Demkovych A. Endogenous intoxication in development of experimental periodontitis of bacterial-immune genesis. Folia Medica. 2023 Feb 28;65(1):149-54. doi: https://doi.org/10.3897/folmed.65.e71970

62. Khilinich YeS, Starchenko II, Davydenko VYu, Nidzelskiy MYa, Davydenko GM. Condition and structural organization of the glandular area mucous membdane of albino rat hard palate under the 30-day-long effect of acrylic. World of Medicine and Biology. 2020;2(72):216-20. doi: https://doi.org/10.26724/2079-8334-2020-2-72-216-220

63. Yokoyama T, Imai K, Hashimoto Y. Comparison of cell viability between mouse-derived ES-D3 cells and Balb/c 3T3 cells using denture-base lining materials. Dent Mater J. 2022 May 31;41(3):481-6.
doi: https://doi.org/10.4012/dmj.2021-302

64. GhiŢĂ RE, Scrieciu M, Mercu ŢV, Popescu SM, Andrei OC, Pitru A, et al. Oral Mucosa Changes Associated with Wearing Removable Acrylic Dentures. Curr Health Sci J. 2020;46(4):344-51.
doi: https://doi.org/10.12865/CHSJ.46.04.04

65. Suharyono S, Peluru HN, Yuniarly E. The behavior of maintenance of removable partial dentures with the incidence of gingivitis in elderly. Journal of Dental Hygiene and Therapy. 2023;4(1):82-7.
doi: https://doi.org/10.36082/jdht.v4i1.1006

66. Lokota YuE, Lokota EYu, Kukharchuk LV. [Analysis of alveolar age atrophy factors, complete diseases and complaints in elderly patients using full removable dental orthopedic structures (literature review)]. Problemy klinichnoi pediatrii. 2020;1-2:60-5. Ukrainian.
doi: https://doi.org/10.24144/1998-6475.2020.47-48.60-65

67. Touloumi F, Suvarna S, Florentine CM, Taylor TD. Custom made device for removal of removable partial denture in a patient with manual impairment. J Prosthodont. 2022 Apr;31(4):362-3.
doi: https://doi.org/10.1111/jopr.13475

68. Kryvchuk OA. [Clinical assessment of the efficiency of the application of the improved technique of manufacturing plastic bases of removable dentures]. Ukrainian Dental Almanac. 2019;3:34-9. Ukrainian.
doi: https://doi.org/10.31718/2409-0255.3.2019.06

69. Kryvchuk OA. [Results of clinical-experimental testing of advanced technology of the manufacture of acrylic plastic bases]. Bulletin of Dentistry. 2019;2:42-6. Ukrainian.
doi: https://doi.org/10.35220/2078-8916-2019-32-2-42-46

70. Yanishen I, Zapara P, Fedotova O, Pogorila A, Sokhan M. Laboratory justification for the selection of a soft substrate and acrylic plastics in the manufacture of two-layer designs of removable dentures. Novini stomatologii. 2019;1(98):41-4. Available from:
https://repo.knmu.edu.ua/bitstream/123456789/23573/1/%d0%af%d0%9d%d0%86%d0%a8%d0%95%d0%9d_%d0%9d%d0%a1.pdf

Стаття надійшла до редакції 12.01.2024;
затверджена до публікації 25.03.2024