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QUALIMETRICS COMPARATIVE EVALUATION OF TOOTH-TECHNICAL DENTAL MATERIALS FOR THE MANUFACTURE OF DENTURES

Abstract. Taking into account the significant number of basic and auxiliary dental materials used in the stages of orthopedic treatment, the urgent need to carry out a comparative qualitative assessment of tooth-technical dental materials, the main function of which is to inform the doctor about their optimal selection, becomes clear. **The purpose** of the study was to conduct a comparative multivariate qualitative analysis of structural and auxiliary dental materials. Of the structural materials for orthopedic dental structures, we studied dental plastics, coating varnishes and cements for permanent fixation of dental prostheses in laboratory and experimental conditions, as well as functional and structural materials (silicone lining and adhesive) and obtained the corresponding qualitative indicators, the informativeness of which is high and fluctuating within the limits: for hot polymerization plastics – (0.343±0.349) bits, for cold polymerization plastics – (0.052±0.203) bits, for coating varnishes (0.169±0.333) bits, for cements for permanent fixation – (0.228±0.297) bits, for adhesive materials – (0.157±0.327) bits. The bond strength (U, kgf/cm²) of the material for soft substrates ranges from (5.29±19.2) kgf/cm²

and meets regulatory requirements. We additionally calculated the corresponding technological indices of metal-dentin biadhesion of cements for permanent fixation, the value of which varies within (2.3÷2.5) units. With the goal of conducting a comparative multifactorial qualitative analysis of structural and auxiliary dental materials, we obtained data that integrally characterize the quality of the material according to a set of indicators using a single method of comprehensive assessment of their properties.

Key words: qualimetric evaluation, dental materials, compliance, dental design.

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ПОРІВНЯЛЬНА КВАЛІМЕТРИЧНА ОЦІНКА ЗУБОТЕХНІЧНИХ СТОМАТОЛОГІЧНИХ МАТЕРІАЛІВ ДЛЯ ВИГОТОВЛЕННЯ ЗУБНИХ ПРОТЕЗІВ

Анотація. Зважаючи на значну кількість основних і допоміжних стоматологічних матеріалів, що використовуються на етапах ортопедичного лікування, стає зрозумілою нагальна потреба у проведенні порівняльної кваліметричної оцінки зуботехнічних стоматологічних матеріалів, основною функцією якої є інформування лікаря щодо оптимального їх підбору. **Метою дослідження** було проведення порівняльного багатofакторного кваліметричного аналізу конструкційних та допоміжних стоматологічних матеріалів. Із конструкційних матеріалів для ортопедичних стоматологічних конструкцій нами в лабораторно-експериментальних умовах вивчені стоматологічні пластмаси, покривні лаки та цементи для постійної фіксації зубних протезів, а також функціонально-конструкційні матеріали (підкладочні силі-

конові та адгезивні) та отримані відповідні кваліметричні показники, інформативність яких висока та коливається у межах: для пластмас гарячої полімеризації – (0,343÷0,349) біт, для пластмас холодної полімеризації – (0,052÷0,203) біт, для покривних лаків (0,169÷0,333) біт, для цементів для постійної фіксації – (0,228÷0,297) біт, для адгезивних матеріалів – (0,157÷0,327) біт. Міцність зв'язку (U , кгс/см²) матеріалу для м'яких підкладок коливається у межах (5,29÷19,2) кгс/см² та відповідає нормативним вимогам. Нами додатково розраховані відповідні технологічні індекси метало-дентинової біадгезії цементів для постійної фіксації, значення яких коливається у межах (2,3÷2,5) од. Маючи на меті проведення порівняльного багатofакторного кваліметричного аналізу конструкційних та допоміжних стоматологічних матеріалів, нами за єдиною методикою комплексної оцінки їх властивостей отримані дані, що інтегрально характеризують якість матеріалу за комплексом показників.

Ключові слова: кваліметрична оцінка, стоматологічні матеріали, комплаєнтність, стоматологічні конструкції.

Introduction. At present, the problem of the relationship between the type of orthopedic construction, the used structural and auxiliary materials, and the frequency and nature of complications during orthopedic treatment with dental prostheses cannot be considered systematically investigated. A decrease in the clinical and technological quality of orthopedic structures immediately after orthopedic treatment and in the distant period can be determined by the properties and technological quality of constructive, auxiliary materials and dental cement used for fixation of the orthopedic structure [2, 4, 6, 8]. Taking into account the significant number of basic and auxiliary dental materials used in the stages of orthopedic treatment, the urgent need to carry out a comparative qualitative assessment of dental technical dental materials, the main function of which is to inform the doctor about their optimal selection, becomes clear. [1]. The existing danger of the negative impact of an unsuccessful selection of dental materials reveals an urgent need for the development and implementation of qualitative approaches in professional activities to ensure the necessary quality of structures and their clinical and functional properties [3, 5].

The existing classifications of dental materials can only conditionally be used when determining the "related" selection of dental materials, since in each specific case of orthopedic treatment, the factors limiting the doctor's selection are the presence of certain dental materials in the medical and preventive institution and, directly, individual patient factors (presence of contraindications to the use of a specific material) [7, 9].

The **purpose** of the study is to conduct a comparative multifactorial qualitative analysis of structural and auxiliary dental materials.

Materials and methods. Of the structural materials for orthopedic dental structures, we studied dental plastics, coating varnishes and cements for permanent fixation of dental prostheses, as well as functional and structural materials (silicone and adhesive linings) in laboratory and experimental conditions.

Qualitative assessment of hot polymerization plastics was investigated according to the indicative properties of structural materials: deformation during compression, bending stress, impact toughness, abrasion resistance of the polymer and specific content of residual monomer and water absorption of the material.

In the system of qualitative assessment of cold polymerization plastics, the indicative properties of structural materials were investigated: deformation during compression, microhardness, microporosity, specific weight of the residual monomer, abrasion resistance of the polymer and specific content residual monomer and water absorption of the material.

The comparative qualitative evaluation of topcoats was performed according to indicators of their basic properties, in particular: structuring time, reflection coefficient, microhardness of samples, surface porosity, ability of varnish to adhere to plastic and metal; varnishes "EDA-03", "Sinma M+V", "Conalor" were studied, and the criteria for evaluation were the requirements contained in ISO-14569.

On the example of the materials "Compomer", "Fuji Plus", "Ketac Cem", a comparative analysis of the quality of cements for permanent fixation of dental denture was performed according to the properties provided by ISO-9917: mixing time, hardening time, film thickness, compressive strength, dissolution acidity and adhesion to metal / dentin.

The physico-mechanical properties of functional and structural dental materials for the production of soft linings for the bases of removable prostheses, according to the Technical Specifications, include: compound consistency (D, mm), compression deformation (S, %), recovery of the material after compression deformation (IB, %), the relative elongation of the material to the moment of rupture (fr) and the bond strength of the soft substrate with the base (acrylic polymers) of the prosthesis (NP, H). The bond strength (U , kgf/cm²) of the material for soft substrates was investigated on the bases made of acrylic polymers (the most common in domestic orthopedic dentistry for the manufacture of the base of removable dentures).

A comparative study of the properties of adhesive materials used to improve the fixation of removable dental prostheses was performed according to the following parameters: consistency, tensile strength, solubility, adhesion to plastic and metal, as well as the level of viscosity.

Research results. For hot polymerization plastics, appropriate qualitative indicators were obtained, their informativeness is high and varies within (0.343÷0.349) bits (Table).

For cold polymerization plastics, corresponding qualitative indicators were also obtained, the informativeness of which is high and ranges from (0.052÷0.203) bits.

In addition, the corresponding technological indices of metal-plastic biadhesion of topcoats were calculated, the value of which varies within (14.0÷11.1) units. Corresponding qualitative indicators were also obtained for the specified materials, the informativeness is high and varies within (0.169÷0.333) bits.

We additionally calculated the corresponding technological indices of metal-dentin biadhesion of cements for permanent fixation, the value of which varies within (2.3÷2.5) units. Corresponding qualitative indicators were also obtained for the specified materials, the informativeness is high and varies within (0.228÷0.297) bits.

The bond strength (U, kgf/cm²) of the material for soft substrates was investigated on the bases made of acrylic polymers (the most common in domestic orthopedic dentistry for the manufacture of the base of removable dental prostheses), ranges between (5.29÷19,2) kgf/cm² and meets regulatory requirements. However, it was found that the index of bond strength of MMP "PM-SN", which is (5.29±0.23) kgf/cm², is somewhat lower than that of the material "Silagum AV Comfort" – (5.85±0,19) kgf/cm² and significantly (p<0.05) lower than that of the "Ufi Gel P" material – (19.2±0.25) kgf/cm² (Table 1).

It was found that at the lowest conditional viscosity, the adhesion of removable dental prostheses decreases and their fixation and stabilization during clinical use is impaired, which significantly prolongs the adaptation period of patients and reduces the quality of life. For adhesive materials used to improve the fixation of removable dental prostheses, corresponding relative standardized and qualitative indicators were obtained, which ranged from (0.157÷0.327) bits.

Conclusions. With the aim of conducting a comparative multifactorial qualitative analysis of structural and auxiliary dental materials, we obtained data that integrally characterize the quality of the material

Table 1

Functional purpose of structural dental materials studied at the laboratory stage and their integral qualimetric indices

Functional purpose of dental material		Researched materials			
1	Acrylic plastics of cold polymerization for the manufacture of the base of a removable prosthesis	ISO-10139	"Protacryl-M"	"Redont"	"Vertex castapres"
		h, bit	0,265	0,289	0,314
2	Acrylic plastics of hot polymerization for the manufacture of the base of a removable prosthesis	ISO-10139	"Ethacryl-02"	"Ftorax"	"Vertex rapid"
		h, bit	0,348	0,343	0,349
3	Acrylic plastics of cold polymerization for the manufacture of fixed dental prostheses	ISO-10477	"Acrodent"	"SNAP"	"TEMPRON"
		h, bit	0,203	0,052	0,176
4	Acrylic plastics of hot polymerization for the manufacture of fixed dental prostheses	ISO-10477	"Sinma M"	"Sinma M+V"	Superpont C+B
		h, bit	0,131	0,027	0,062
5	Covering varnish (ensuring compliance)	ISO-14569	"EDA-03"	"Sinma M+V"	"Conalor"
		h, bit	0,169	0,333	0,263
6	Dental cement for permanent fixation of prostheses	ISO-9917	"Compo-mer"	"Fuji Plus"	"Ketac Cem"
		h, bit	0,297	0,228	0,266
7	Adhesive materials for improving the quality of fixation of removable dental prostheses	ISO-10873	"Stomafix"	"Corega"	"Lacalut"
		h, bit	0,317	0,327	0,157
8	Silicone lining materials for removable structures of dental prostheses	ISO-10139	"Ufi Gel P"	"PM-SN"	"Silagum"
		h, bit	Voco	"Stoma"	DMG
			0,999	0,499	0,665

Note: ISO is the international standard for the quality of dental material; h is a generalized indicator of the quality of the dental material, taking into account its indicative properties, provided by ISO, bit

according to a set of indicators using a single method of comprehensive assessment of their properties. We used the obtained data to substantiate and develop a professional advisory system for the selection of compliant dental materials in the manufacture of removable and non-removable structures of dental prostheses.

Thus, our own scientific achievements regarding the comparative evaluation of the physical-mechanical and clinical-technological features of structural and auxiliary dental materials with the performance of their comparative qualitative assessment according to the indicators of properties significant in the orthopedic dentistry clinic are comprehensively presented.

Bibliography:

1. Appleby R.C., Kirchoff W.F. Immediate maxillary denture impression. *J. Prosth Dent.* 2012. №5. P. 443.
2. Bradm M., Canston B.E. Use of polymeric material in dentistry. *Flastm Polim.* 2011. №153. P. 140-144.
3. Donovan T.E., Hirst R.G., Campagni W.V. Physical properties of acrylic resin polemerized by four different techniques. *The Journal of Prosthetic Dentistry.* 2015. № 4. P. 522- 524.
4. Hill E.E., Lott J. A clinically focused discussion of luting materials. *Dent J.* 2011. №56(1). P. 67-76. doi: 10.1111/j.1834-7819.2010.01297.x.
5. ISO 9917-1:2007-1:2007. Dentistry – Water-based cements – Part 1: Powder/liquid acid-base cements. 2007;2:23. URL: <https://www.iso.org/standard/45818.html>
6. Рожко М., Попович З., Куроєдова В. Стоматологія. Київ: Медицина. 2013. Т. 1. 872 с.
7. Sailer I., Balmer M., Husler J., Hammerle CHF., Kanel S., Thoma D.S. 10-year randomized trial (RCT) of zirconia-ceramic and metal-ceramic fixed dental prostheses. *J Dent.* 2018. №76. P. 32-9. doi: 10.1016/j.jdent.2018.05.015. PMID: 29807060.
8. Янішен І. В., Федотова О. Л. Проблема комплаєнтно-орієнтованих інновацій зуботехнічного матеріалознавства в контексті підвищення ефективності стоматологічного лікування. *Український стоматологічний альманах.* 2016. №4. С. 60-68. URL: http://nbuv.gov.ua/UJRN/Usa_2016_4_15

References:

1. Appleby, R.C. & Kirchoff, W.F. (2012). Immediate maxillary denture impression. *J. Prosth Dent.*, 5, 443.
2. Bradm, M. & Canston, B.E. (2011). Use of polymeric material in dentistry. *Flastm Polim.*, 153, 140-144.
3. Donovan, T.E., Hirst, R.G. & Campagni, W.V. (2015). Physical properties of acrylic resin polemerized by four different techniques. *The Journal of Prosthetic Dentistry*, 4, 522-524.
4. Hill, E.E. & Lot,t J. (2011). A clinically focused discussion of luting materials. *Dent J.*, 56(1), 67-76. doi: 10.1111/j.1834-7819.2010.01297.x.
5. ISO 9917-1:2007-1:2007. (2007) Dentistry – Water-based cements – Part 1: Powder/liquid acid-base cements.;2:23. Available at: <https://www.iso.org/standard/45818.html>
6. Rozhko, M., Popovych, Z., Kurojedova, V. (2013). *Stomatologija [Dentistry]*. Kyi'v: Medycyna [in Ukrainian].
7. Sailer, I, Balmer, M, Husler, J, Hammerle ,CHF., Kanel, S. & Thoma, D.S. 10-year randomized trial (RCT) of zirconia-ceramic and metal-ceramic fixed dental prostheses. *J Dent.* 2018;76:32-9. doi: 10.1016/j.jdent.2018.05.015.
8. Yanishen, I.V. & Fedotova, O.L. (2016). Problema komplajentno-orijentovanyh innovacij zubotehnichnogo materialoznavstva v konteksti pidvyshhennja efektyvnosti stomatologichnogo likuvannja [The problem of compliance-oriented innovations in dental materials science in the context of improving the effectiveness of dental treatment]. *Ukrai'ns'kyj stomatologichnyj al'manah – Ukrainian dental Almanac.* 4, 60-68 Available at: http://nbuv.gov.ua/UJRN/Usa_2016_4_15 [in Ukrainian]