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Laboratory Justification for the Selection of a Soft Substrate and Acrylic Plastics in the Manufacture of Two-layer Designs of Removable Dentures

Лабораторне обґрунтування добору м'якої підкладки та акрилової пластмаси при виготовленні двошарових конструкцій знімних протезів

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Purpose: *To improve the quality of orthopedic treatment of patients with removable structures with a wrapping part with two-layer bases due to the scientific substantiation of the selection of both soft substrates and acrylic plastics.* ***Methods:*** *A comparative assessment of the strength of the connection was carried out jointly with the employees of the central factory laboratory of JSC "Stoma" (Kharkiv, Ukraine) in accordance with the requirements of the international standard ISO-10139.* ***Results:*** *The results showed that the system of domestic materials "PM-SN" - "Stomalit" appeared with the highest degree of compliance.* ***Conclusions:*** *In order to prevent the negative influence of unsuccessful selection of dental materials, it is necessary to use modern approaches in professional activity to ensure the necessary quality of structures and their clinical and functional properties and apply only the most compliant system.*

Key words: *removable prostheses, A-silicon substrate material, acrylic plastics, compliance, durability of the joint.*

Мета: *Підвищення якості ортопедичного лікування пацієнтів знімними конструкціями з обтуруючою частиною із двошаровими базисами за допомогою наукового обґрунтування добору як м'якої підкладки, так і акрилової пластмаси.* ***Методи:*** *Порівняльну оцінку міцності зв'язку проводили спільно зі співробітниками центральної заводської лабораторії АТ «Стома» (Харків, Україна) відповідно до вимог міжнародного стандарту ISO-10139.* ***Результати:*** *Найбільший ступінь комплаєнтності мала система вітчизняних матеріалів «ПМ-СН»-«Стоматіт».* ***Висновки:*** *Для того щоб запобігти негативному впливу невдалого підбору стоматологічних матеріалів потрібно використовувати сучасні підходи в професійній діяльності задля забезпечення потрібної якості конструкцій та їх клініко-функціональних властивостей і застосовувати лише найкомплаєнтіші системи.*

Ключові слова: *знімні протези, А-силіконовий підкладковий матеріал, акрилова пластмаса, комплаєнтність, міцність з'єднання.*

INTRODUCTION

Patients with damage to the maxillofacial area make up a very difficult group among patients in dental clinics [2, 4]. Treatment and rehabilitation of patients with acquired maxillo-facial defects are the most urgent medical and social problems of modern dentistry in today's unfortunately difficult time [1]. Especially complicated rehabilitation of patients with acquired defects of the upper jaw, which seriously disturbs the vital functions of breathing, swallowing, sound formation, chewing. There is currently no clear concept of driving this category of patients. There are divergences in the use of jaw prostheses [10].

At present, structures of different types, replacing defects of dentitions, missing bone structures and separating the oral cavity with the maxillary sinus or nasal cavity using obturators, are used. However, they have a significant disadvantage: part of the prosthesis that closes the defect, enters its cavity and injures the mucous membrane along the edges of the defect. Therefore, the proposed designs need to be refined. According to various data, 20-26 % of patients who received prostheses do not use them, and 37 % are forced to adapt to poor-quality prosthetics [7, 12].

In this regard, the main goal and objectives are the search for rehabilitation measures and a strictly individual, differ-

entiated methodological approach to orthopedic treatment of operated patients for oncological diseases, after resection of the upper jaw in order to improve the quality of life of patients [3, 7].

In our time, due to the large number of technological innovations, orthopedic dentistry has raised and increasingly stringent requirements for basic and auxiliary dental materials, since their qualitative characteristics largely determine the functional value of the prosthesis. Therefore, there is a need for a differentiated approach to the choice of material for each orthopedic work individually. This is due, first of all, to the large variety of materials supplied to the domestic market. On the other hand, there is a danger of the negative influence of the unsuccessful selection of dental materials, which reveals the urgent need for using qualimetric approaches in professional activity in order to provide the necessary quality of structures and their clinical and functional properties [9, 11].

That is why the purpose of our study is to improve the quality of orthopedic treatment of patients with removable structures with a wrapping part with two-layer bases due to scientific substantiation of the selection of both soft substrates and acrylic plastics.

MATERIAL AND METHODS

A comparative assessment of the bond strength of A-silicone support materials with demountable denture constructs made of acrylic plastics by various laboratory technologies was carried out jointly with the employees of the central factory laboratory of JSC «Stoma» (Kharkiv, Ukraine) in accordance with the requirements of the international ISO-10139 certified standard PVC foam materials "PM-S" of JSC «Stoma», "PM-S extra" of JSC «Stoma», "PM-SN" of JSC «Stoma», "Ufi Gel P" Voco, "Silagum" of DMG and acrylic plastics for manufacturing bases about theses "Stomalite" JSC «Stoma», "Pallopress" Ivoclar, "Villacryl H Plus" Zhermak.

Determination of the bond strength of a soft substrate with an acrylic base (УП, Н) was carried out on specially designed samples consisting of a sandwich: AB-SS-AB. The manufacture of base elements (AB) from acrylic polymer is carried out in accordance with the instructions. The production of a soft substrate and its layering on the surface of the base elements are made in accordance with the instructions for each of the materials used. Prior to testing, the samples after the structurization of the soft substrate were kept for 1 hour. At carrying out of tests, samples were fixed in mechanical capture of device "PMM-250" and initiated the mechanism of a rupture. The velocity of the active traction was (500,0 ± 50,0) mm / min; at the time of the rupture of the sample recorded force (F). The results of the tests were introduced into a specially developed primary document "Protocol for the registration of test results of soft substrates for the strength of the bond with base acrylates". The strength of the bond was determined by the formula $U = F/S$ (N/cm^2), F – force at the time of the sample break (kgs); S is the area of the specimen given by the design of metal grips (5,2 cm^2).

For visualization of data, graphic forms are used in the form of histograms, column charts, polygon distribution of the analyzed features, as well as the construction of correlograms and correlation galaxies. In analyzing the results of the study, licensed software products ("STATISTICA", "EXCEL" with an additional set of programs) were used on the PC, which allowed to provide the necessary standardization of the process and the procedure of clinical statistical analysis of the data [5, 6, 8].

RESULTS AND DISCUSSION

A comparative analysis of the study of the adhesion of A-silicon substrate materials to removable denture constructs made of acrylic plastics by various laboratory technologies included the results of a laboratory study of one of the most important physico-mechanical properties – bond strength.

Investigation of bond strength ($U, kgf/cm^2$) of material for soft substrates "PM-S" and acrylic polymer "Stomalite" found that its index is (5,3 ± 0,2) kgf/cm^2 (Table.) and conforms to the regulatory requirements of ISO-10139. However, it was found that the indicator of the bond strength of the PM-S with the plastic "Pallopress" is (5,5 ± 0,3) kgf/cm^2, which is significantly ($p < 0,05$) more than the contact the material is "Villacryl H Plus" – (5,1 ± 0,2) kgf/cm^2.

Table. Results of laboratory study of bond strength A-silicon substrate materials for the manufacture of two-layer denture removable denture constructs made of acrylic plastics according to different laboratory technologies, kgf/sm²

A-silicon SM / Plastics	"PM-S" JSC «Stoma»	"PM-S extra" JSC «Stoma»	"PM-SN" JSC «Stoma»	«Ufi Gel P» «VOCO»	«Silagum» DMG
«Stomalite» JSC «Stoma»	5,3±0,2	6,9±0,2	9,3±0,2	9,1±0,2	5,9±0,2
«Pallopress» Ivoclar	5,5±0,3	6,8±0,1	9,0±0,1	8,9±0,3	6,0±0,3
«Villacryl H Plus» Zhermak	5,1±0,2	6,7±0,2	8,9±0,2	8,8±0,1	5,8±0,3

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The strength of the connection between the PM-S extra and the acrylic basis made from "Stomalite" is (6,9 ± 0,2) kgf/cm^2, which exceeds the indicative index by 72,5 % and is significantly ($p < 0,05$) is greater than in the combination of PM-S extra with Pallopress (6,8 ± 0,1) kgf/cm^2 and Villacryl H Plus (6,7 ± 0,2) kgf/cm^2.

Polyvinylsiloxane material "PM-SN" is connected with acrylic plastic "Stomalite" with strength in (9,3 ± 0,2) kgf/cm^2. This indicator significantly (2,3 times) exceeds the indicative value (≥ 4,0 kgf/cm^2) according to ISO-10139, which meets the quality requirements, and significantly ($p < 0,01$) exceeds the results of research on the strength of the connection between "PM-SN" and "Pallopress" and "PM-SN" and "Villacryl H Plus", which are (9,0 ± 0,1) kgf/cm^2 and (8,9 ± 0,2) kgf/cm^2, respectively, and also meet the ISO requirements for this indicator.

The study of the strength of the bond between the Ufi Gel P substrate and the Stomalit acrylic base plastics showed one of the best results throughout the study (9,1 ± 0,2) kgf/cm^2, however, it is still inferior to the leading position of the system "PM-SN" – "Stomalit" by 2,2 %. However, in the "Ufi Gel P" bonding comparison group with other plastics, the result of the "Ufi Gel P" – "Stomalit" system was significantly ($p < 0,05$) better than the "Ufi Gel P" – "Pallopress" system – (8,9 ± 0,3) kgf/cm^2, which in turn inferior to the complex "Ufi Gel P" – "Villacryl H Plus" (8,8 ± 0,1) kgf/cm^2. All of these systems comply with ISO-10139.

The strength of the connection between materials "Silagum" and "Stomalite" is (5,9 ± 0,2) kgf/cm^2, which corresponds to the normative requirements of ISO-10139 according to this indicator, but reliably ($p < 0,05$) is slightly inferior to the system "Silagum" –"Pallopress" with a value of (6,0 ± 0,3) kgf/cm^2, but 2,5 % ahead of the connection "Silagum" and "Villacryl H Plus" – (5,8 ± 0,3) kgf/cm^2 ($p < 0,05$).

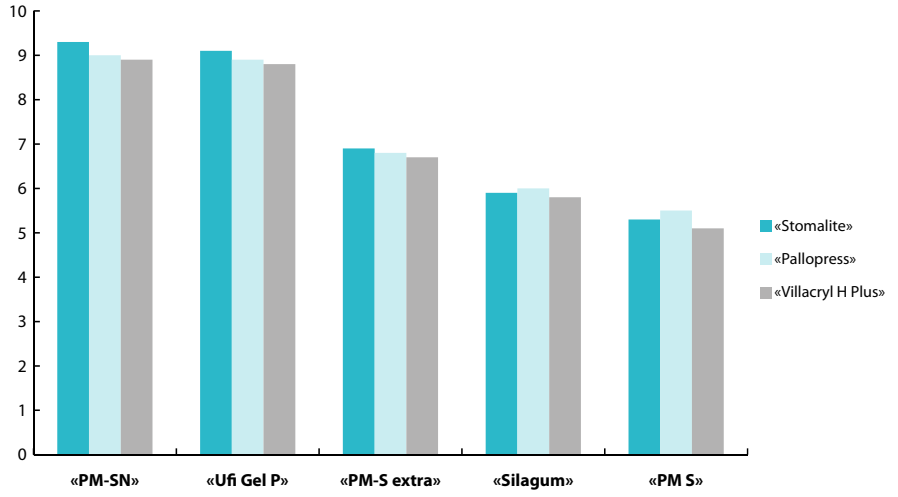

Fig. A comparative analysis of the study of the bond strength of A-silicon substrate materials for the manufacture of two-layer removable denture structures made of acrylic plastics by different laboratory techniques

A generalized analysis of the results showed that all the studied systems meet the regulatory requirements of ISO-10139. However, the highest step in determining the suitability for the strength of the connection is the system of domestic materials "PM-SN" – "Stomalite" (Fig.).

CONCLUSIONS

Obviously, today the relevance of the illuminated problem is high the position and search for rehabilitation measures and a strictly individual, differentiated methodological approach to orthopedic treatment of patients with dental defects are increasingly important and necessary. More and more stringent requirements for basic and auxiliary stomatological materials are put forward, as their qualitative characteristics largely determine the functional value of the prosthesis. Studying and analyzing their properties makes it possible to understand and apply the necessary material in a particular clinical situation to best meet the needs of orthopedic treatment. A comparative analysis of the study of the connection of A-silicone support materials and removable structures of dentures made of acrylic plastics by various laboratory technologies included the results of a laboratory study of one of the most important physico-mechanical properties – bond strength. The results showed that the system of materials "PM-SN" – "Stomalite" appeared with the highest degree of compliance, other combinations in order of decreasing the strength of the connection were as follows: "Ufi Gel P" - "Stomalite", "PM-SN" - "Pallopress", "PM-SN" - "Villacryl H Plus", "Ufi Gel P"-"Pallopress", "Ufi Gel P"-"Villacryl H Plus", "PM-S extra"-"Pallopress", "PM-S extra"-"Villacryl H Plus", "Silagum"-"Pallopress", "Silagum"-"Stomalit", "Silagum"-"Stomalit", "Silagum"-"Villacryl H Plus", "PM-S" - "Pallopress", "PM-S"-"Stomalit", "PM-S"-"Villacryl H Plus".

Therefore, in order to prevent the negative influence of the unsuccessful selection of dental materials, it is necessary to use modern approaches in professional work to ensure the necessary quality of structures and their clinical and functional properties and apply only the most compliant system.

Therefore, the prospects for further research are obvious and the work in this aspect can be considered not only necessary, but necessary, as conducting studies of the compliance of materials will undoubtedly significantly help the dentist-orthopedist to determine the choice of structural materials in the manufacture of two-layer dentures.

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