LABORATORY TESTS OF SOFT PADS FOR REMOVABLE PROSTHETICS AND ORTHOPEDIC TREATMENT IN THE PRESENCE OF ACUTE BONE PROTECTION

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Abstract. *On the basis of the Kazakh National Technical University K.I. Satpayev, physical and mechanical studies of soft pads for removable prosthetics were carried out; hot curing elastic silicone materials - Fuji, Mukopren and GosSil. The results of the study of the conditional elongation strength showed the maximum value for the GosSil material, the Mukopren material had the highest coefficient of elongation, the GosSil material had a high residual elongation, the measurement of the elongation stress revealed the highest elasticity of the Fuji material. Also, in the clinic of dentistry, prosthetics of 35 patients were carried out with full removable dentures with a soft lining from the materials under study in the presence of a torus and sharp bone protrusions. Observation for 180 days showed that the fabricated removable dentures with a soft lining, taking into account the pain sensitivity of the oral mucosa, provides quick adaptation and good chewing efficiency, improves gnathodynamometry indicators.*

Key words: *silicone material, Acrylic soft pad, clinical dentistry, liner.*

Removable dentures made of acrylic plastic due to the combination of such properties as mechanical strength, aesthetic properties, resistance to oral fluid, weak alkalis and acids, low density, the ability to form at low pressures in modern dentistry remain the main structural material [1]. However, there are a number of disadvantages, including shrinkage, porosity, presence of residual monomer, residual stress, etc. [2, 7, 11, 13]. The long-term use of acrylates has allowed doctors to determine both the indications and contraindications for their use. For example, in the presence of bony protrusions, exostoses, it is not always possible to clearly and well isolate a site of the oral mucosa (OOM) [2, 9, 10, 13]. Also, the technological process of manufacturing removable dentures from acrylates itself does not allow to exclude the presence of residual monomer and other negative factors in dentures, as a result of which patients often have various complications and changes in functional parameters, even in a worker of an industrial enterprise [3, 4, 5, 6, 12, 13, 18]

The complex of the above negative factors was the reason for the development of soft pads in dentistry. Soft elastic lining materials provide better adhesion of the prosthesis to the oral mucosa, and can also be used in the manufacture of combined dentures and maxillofacial prostheses. In recent years, they have been widely used for complications caused by dentures made of acrylates [9, 14, 16, 17].

World practice shows that all lining materials used in the clinic of orthopedic dentistry have different physical, mechanical and chemical characteristics that determine the main indications for their use.

Acrylic soft pads have good adhesion to acrylic plastic, but they become aged relatively quickly, resulting in a loss of elasticity. Polyvinyl chloride (PVC) materials resist abrasion better than acrylic and silicone, and are stronger adhered to the base than silicone compounds [7, 8, 9]

Purpose of the research is to study in laboratory conditions the physical and mechanical

properties of soft linings, widely used in clinical practice, as well as to use them in the presence of bony protrusions of edentulous jaws.

Materials and research methods. The research material was hot-curing silicone liners widely used in clinical dentistry. In the dental clinic "Citydent" based on the Kazakh National University named Al-Farabi conducted clinical, laboratory examinations, and orthopedic treatment of 35 patients with complete absence of teeth, with the presence of bony protrusions on the jaw bones. Measurements of the pain sensitivity of the oral mucosa and the determination of the teeth to the load were carried out by devices of our own improvement (certificate for rational proposal No. 570 dated 05.07.2007) (certificate for rational proposal No. 568 dated 05.01.2007). All patients, after a complete examination, were made removable dentures with a soft lining.

In the laboratory of resistance of materials of the Kazakh National Technical University named after K.I. Satpayev, we carried out physical and mechanical studies of materials. For the study, materials for soft linings made in Japan (Fuji), Germany (Mukopren) and Russia (GosSil) were used.

To compare the results obtained, samples were made in a dental laboratory based on the Kazakh National Medical University named after S. D. Asfendiyarova a highly qualified dental technician. The studies were carried out on a MI 40kN apparatus with a high-speed computer. Each sample was measured 5 times; the resulting arithmetic mean value was entered into the data. Compositions based on low-molecular-weight silicone rubbers were investigated - an elastic silicone material for hot polymerization Mukopren; Fuji elastic hot cure silicone material, GosSil elastic hot cure silicone material. We have determined the conditional strength (σp), relative elongation (Ɛ), permanent elongation (Ɛ OST) and stress at elongation (σ). The essence of the method consists in stretching the specimens at a constant rate to rupture, measuring the force at given elongations and at the moment of rupture and elongation of the specimens at the moment of rupture. The samples were cut in the form of a rectangular strip. Parallel marks were applied to the midsection to measure elongation.

The conventional strength (Ơp) in MPa of the specimens was calculated by the formula:

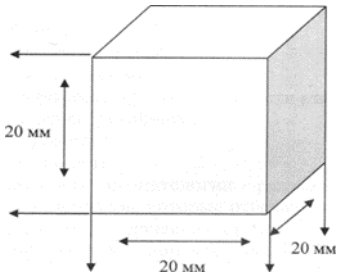
- Ơp = Pp / S, where Pp is the limiting value at which the sample ruptures, MH (kgf); S is the cross-sectional area of the sample, m (cm);
- The relative elongation (Ɛ) at rupture of the samples in % was calculated by the formula: Ɛ = (Δ1 / 1) 100%, where Δ I is the absolute elongation of the specimen at the moment preceding the rupture; I is the free (between) clamps the length of the sample before the load is applied.
- The stress at elongation (Ơ) in MPa was calculated by the formula G = Δ1 / S, where S is the cross-sectional area of the sample, m2; Δ 1 is the absolute elongation of the sample at the moment preceding the rupture;
- Residual elongation (Ɛ0CT) after rupture was determined as follows. The parts of the torn sample, freed from the grips, were placed on a flat surface, and 1 minute after the rupture, the distance between the marks of the two parts of the sample folded at the place of rupture was measured.
- Residual deformation after rupture (Ɛ rest) in percent was calculated by the formula: Ɛ rest = (Δ 1res / 1) • 100%, where Δ 1res is the absolute elongation of the specimen at the moment preceding rupture. 1 - free (between) clamps the length of the sample before the application of the load.

Determination of compressive strength. The method of determination consists in finding the load at which the specimen fractures during compression under static loading. The compression test is carried out by placing a parallelepiped or cylindrical specimen between two parallel-hardened steel plates approaching at a constant speed. To avoid buckling, the height of the specimen should be commensurate with its transverse dimensions. The ratio of the height to the minimum size of the base

should be between 1.5 and 2.9.

The compressive strength Ơ s is calculated by the formula: Os = Pc / S, where Pc is the breaking force load, MN; S - cross section of the sample, m2.

We have made cubic samples with dimensions h = 20mm; q = 20 mm; δ = 20 mm, which are shown schematically in Figure 1.

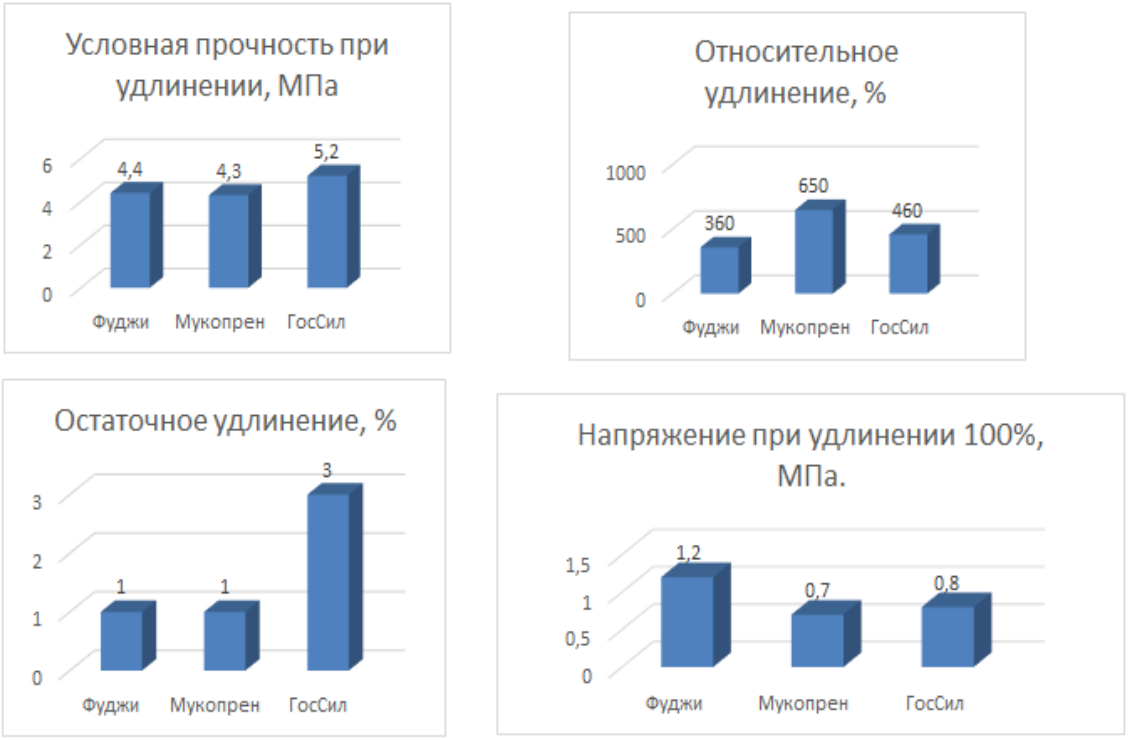


Figures # 1 - Schematic representation of a sample for determining the ultimate compressive strength.

We were guided by regulatory documents: GOST 19807-91, GOST 263-75, GOST 262-73, GOST 270-75, [14, 15, 16]

Results of the study. Comparative physical and mechanical characteristics of silicone elastic pads are shown in Figures 2.

Investigated materials



Figures No. 2. Physical and mechanical characteristics of silicone elastic pads.

In the study of the relative strength at elongation, the material "GosSil" had a maximum value

of -5.2 + 0.170 MPa. Silicone materials are somewhat inferior to him in this indicator - Fuji, Mukopren (4.4 + 0.138 MPa and 4.3 + 0.156 MPa, respectively).

The highest coefficient of relative elongation (650%) is possessed by the material "Mukopren", which characterizes its very high strength. GosSil is somewhat less important - 460%. Fuji material has a lower rate of 360%.

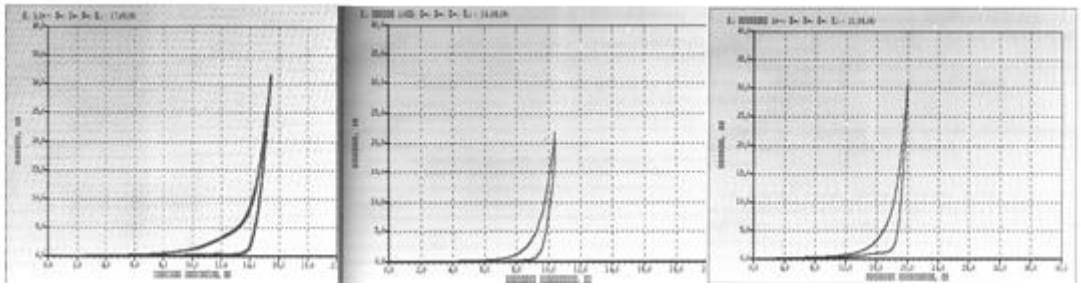
In the study of permanent elongation, a slightly different picture was observed. Fuji and Mukopren had the minimum value of this indicator - 1.0%, while the GosSil material had a higher value - 3.0%.

Approximately the same values for the material "Mukopren" and "GosSil" (0.7 MPa and 0.8 MPa) were obtained when measuring the stress at 100% elongation, while Fuji had a slightly higher elasticity of 1.2 MPa.

Material research data for determining compressive strength are presented in graphical form (Fig. No. 3)

As it can be seen from the graph, the material of GosSil is restored to its original form 2 times faster than Mukopren and Fuji. The stress relief during the study was faster for the GosSil material.

We also see that the Mukopren material, before reaching three tons, collapses, and GosSil continues to take a large load. This means that GosSil's performance is higher in comparison with other materials.



Fuji material **Mucoprene material** **GosSil material**

Figure №3. Determination of compressive strength

Orthopedic treatment of 35 patients was carried out in the “Citident” clinic, in whom a pronounced bony protrusion in the upper jaw in the form of a torus and other areas of the alveolar bones of both jaws was revealed. The examined patients complained of pain under the prosthesis and a violation of their fixation and stabilization in 100% of cases. The periods of use of prostheses were very different (from one to ten years). Anamnesis revealed a complex extraction of teeth, especially the chewing teeth on the lower jaw, which led to the appearance of sharp edges on the alveolar process.

An objective examination of dentures shows traces of numerous medical corrections on them in the area of the bony protrusion or sharp edges of the alveolar process.

When examining the oral cavity, most often, sharp bony protrusions were located on the upper jaw in the region of the tubercle and, in some cases, in the region of the canine and premolars from the vestibular side. The most pronounced bony protrusions in most cases are concentrated in the area of the torus, the severity of which had varying degrees.

Sharp bony protrusions on the lower jaw were most often found in the region of the inner oblique line and in the retromolar region; exostoses were located in the region of the lingual premolars and canines on the vestibular surface of the alveolar process.

In our work, according to the degree of pain sensitivity of the torus, we divided them into 3 degrees: 1 group - mild, but bone formations with clear boundaries, and pain appears with strong pressure; Group 2 - bone formation with indistinct or clear boundaries occupies a large area of the hard palate and pain on palpation; Group 3 - the palatal torus has an indistinct border, can occupy an indefinite area of the palatine suture, painful when touched. Depending on the indices of pain

sensitivity, the patients were divided into 3 groups: in group 1 - esthesiometry over 10 g/cm^2, in group 2 - up to 10 g/cm^2, and in group 3 - up to 5 g/cm^2.

To determine the pain sensitivity of the oral mucosa, we used our improved esthesiometer. For an objective assessment of pain sensitivity, the measurement points in the oral cavity were determined. This is the area of the sixth teeth and central incisors. In addition, we measured the most sensitive points in the oral cavity, i.e. area of the torus, palatine suture, area of bone protrusions. The research results are shown in table -1.

Table # 1.

The degree of pain sensitivity of the alveolar ridge mucosa in patients with complete absence of teeth (in g/cm^2) before and after the manufacture of removable dentures with a soft lining of the upper and lower edentulous jaws.

Field of study	Indicators of aesthesiometry						Total patients	
	up to 5 (g/cm^2)		up to 10 (g/cm^2)		over 10 (g/cm^2)			
	treatment		treatment		treatment		treatment	
	Before	After	Before	After	Before	After	Before	After
Incisor and molar area	20	4	9	5	6	26	35	35
Torus area	18	5	10	6	3	20	31	31

Analysis of the table shows that the largest number of patients before prosthetics had a level of pain sensitivity in the area of the alveolar ridge and torus up to 5 g/cm^2, then up to 10 g/cm^2, the smallest number of patients had indicators above 10 g / cm2. After orthopedic treatment, the number of persons with esthesiometry indices exceeding 10 g / cm2 has sharply increased, which indicates the positive effect of the manufactured prostheses. After prosthetics, we observed significant increases in indicators in the area of standard points. This trend was also observed in the sensitive areas. It can be assumed that the decrease in the sensitivity of the oral mucosa after the treatment with a soft lining is explained by the positive effect of the soft lining, and the restoration of the functional parameters of the maxillofacial region.

We carried out the observation on days 1, 3, 7, 90, 180. In the first days of using removable plate prostheses with a soft lining, patients anxiously expected pain sensations. Improvement of functional qualities allowed patients to fully use prostheses from the first days. Patients complained of pain in certain points under the prosthesis, which were easily eliminated. On the 3rd, 7th day of observation, pain was no longer noted at certain points on the prosthetic bed, the patients fully performed the act of chewing and felt comfortable. After 7, 10 days, the patients fully adapted, successfully used prostheses and had no complaints. Patients noted better fixation of prostheses, no pain under the prosthesis, but some remained anxious that pain would appear or something might happen to the prosthesis. Follow-up for 6 months showed that when using removable dentures with a soft lining, no complications were observed.

In the presence of pronounced bony protrusions, tori, exostoses and atrophy of alveolar processes of varying degrees, the use of soft pads revealed 100% effectiveness of orthopedic treatment. Patients are provided with comfort and functionally complete prostheses.

For an objective assessment of the functional efficiency of removable dentures, we carried out gnatodynamometric studies. At the same time, it turned out that in the presence of removable prostheses, the indicators of gnatodynamometry were from 20 kg/cm^2 to 60 kg/cm^2. The highest indices of gnatodynamometry were in the complete absence of teeth with insignificant atrophy of the alveolar processes up to 40 kg/cm^2 (I - class according to Schroder). In the presence of complete removable dentures, the lowest indices were with significant atrophy of the alveolar processes 20 kg/cm^2 2 (III-class according to Schroder). Despite the low indications of gnatodynamometry, patients with significant atrophy of the alveolar process with prostheses with soft lining have adapted well to the existing prostheses, providing themselves with a satisfactory chewing function and good diction.

Conclusion: - Physical and mechanical studies of Fuji, Mukopren and GosSil soft linings have shown their sufficient efficiency and the possibility of widespread use in the clinic of orthopedic dentistry:

- With proper observance of the technological stages of the manufacture of prostheses, they can serve a sufficient time in accordance with the instructions of the manufacturer:
- We recommend for wide clinical practice the use of soft pads Fuji, Mukopren and GosSil for the manufacture of two-layer bases in the presence of a pronounced torus, bony protrusions of varying degrees, taking into account the level of pain sensitivity of the oral mucosa:
- Determination of pain sensitivity and gnathodynamometry of removable dentures are additional methods that ensure the manufacture of effective complete removable dentures.

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