Features of physical and mechanical properties of materials used in orthopedic rehabilitation of patients

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Abstract. Basic materials have been studied. Types of applied basic materials, readings for application are considered. In a comparative aspect, their physical and mechanical properties are considered, and features arising in the manufacture of dental prostheses are indicated.

The relationship of oral mucosa with dental prosthesis materials remains one of the main problems in dental prosthetics. Artificial prosthesis material is foreign and causes adaptive reactions of patients’ body, at that tissues of oral cavity are in state of homeostasis, preserving structure and function [1, 2]. In addition to the fact that dental prostheses must correspond to the size and shape of the prosthetic bed, the prosthetic material must have physical and mechanical properties that allow to withstand chewing loads, and at the same time have the most sparing effect on mucous membrane tissues [3, 4, 5]. Variety of readings to application of basic plastics is possible due to difference of their physical and mechanical properties [6]. The purpose of our research was to study the physical and mechanical properties of basic materials used in dentistry.

Density is the ratio of body weight to its volume expressed in g/cm³. The density of the substance in almost all cases is equal to the specific weight. Therefore, when selecting the structural material of prostheses, its specific gravity is of great importance.

Polymethyl methacrylate has the highest density of thermoplastic materials and polypropylene has the lowest density (figure 1).

Figure 1. Density of thermoplastic materials (g/cm³).
Melting point is the temperature at which a solid crystalline body makes a transition to a liquid state, expressed in °C. The thermoplastics in the cartridges are heated, then injected under pressure into the cuvette in which the gate mold is located. For thermoplastics of some groups it is necessary to pre-warm the runner system, and for other groups this stage is not carried out.

To prevent material decomposition due to overheating, it is necessary to observe the heating temperature control (figure 2).

![Figure 2. Melting point of thermoplastic materials (°C).](image)

Strength is the property of the material to resist external forces without breaking or deforming, expressed in Mn/m². In use, the denture is subject to a chewing load and it is necessary that the material used is sufficiently strong.

Strength indices of thermoinjection materials are determined at tension (figure 3), compression (figure 4) and bending (figure 5).

![Figure 3. Tensile strength of thermoplastic materials (Mn/m²).](image)

![Figure 4. Compression strength of thermoplastic materials (Mn/m²).](image)
Figure 5. Bending strength of thermoplastic materials (Mn/m²).

Elasticity is the ability of a material to change shape under an external load and to restore shape after removing that load. After the applied load, a return to the previous shape will occur if the applied force has not exceeded a limit value called the elastic limit.

Elasticity is necessary for the base material to resist the action of chewing forces, preventing shoulder loads on the teeth.

Modulus of elasticity is determined at tension (figure 6) and bending (figure 7), unit of measurement of modulus of elasticity Mn/m².

Figure 6. Modulus of elasticity of thermoplastic materials at tension (Mn/m²).

Figure 7. Modulus of elasticity of thermoplastic materials at bending (Mn/m²).
Removable structures made of thermoplastic basic materials, the patient repeatedly has to be removed from the oral cavity and installed again, during operation the structure is subjected to constant and variable physical loads. Specific toughness is determined for characterisation of strength properties of thermoinjection material at action of dynamic load on it.

Toughness is the ability of a material to resist impact loads and is expressed as kJ/m². The material having a lower toughness is more brittle (figure 8).

The elongation is the ratio of the increment of the length of the sample after its rupture to the original design length and is expressed in% (figure 9).

Water absorption - ability of material or article to absorb and retain water in pores and capillaries is expressed in%. Dental prostheses have been in the oral cavity for a long time, so water absorption for orthopedic structures is an important indicator. In the oral cavity, this indicator is insignificant in percentage terms, as saliva, having left the duct of the salivary gland, entering the oral cavity, changes its composition and becomes oral fluid. Permissible water absorption of basic material reaches not more than 0,7%, polyamide - 26%, polyoxymethylene – 0,2%, polypropylene – 0,5%, polymethylmethacrylate – 0,45-0,6%.

In terms of the presented characteristics of thermoplastic materials, the best for making prostheses is polymethylmethacrylate, the second place is polyoxymethylene.

Thus, knowledge of the physical and mechanical properties of the materials used for the manufacture of dental prostheses is necessary for their reasonable application depending on the clinical situation in the patient.
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