Some features of the physicochemical properties of structural materials used in the clinic of orthopedic dentistry

N N Medvedeva, D V Kiprin, PA Samotesov, V V Salmin and T L Marugina

Federal State Budgetary Educational Institution of Higher Education "Krasnoyarsk State Medical University named after Professor V.F. Voyno-Yasenetsky", Ministry of Health of the Russian Federation, PartizanZheleznyak st.1, Krasnoyarsk 660022, Russia

E-mail: d_kiprin@mail.ru

Abstract. The study of modern basic materials used in orthopedic dentistry has been carried out. The basic physicochemical properties of the base materials, the characteristics of the materials, the features of the influence of the base materials on the tissue of the prosthetic field have been considered.

Characterized by increased strength, the denture bases withstand significant masticatory force due to the presence in the structure of the polymer chain, areas of crystallinity, generally acting as reinforcing elements. Thermoinjection materials have an accurate fit and stable fixation, providing minimal pathological effect on the mucosa [1, 2].

There is no residual monomer in the structures, which reduces the risk of toxic and allergic reactions [3, 4, 5]. Dentures are very aesthetic, because they are made of translucent material corresponding to the natural color of the gums, and for their fixation, alveolar-dental clasps are used, invisible to the eye. The absence of metal clasps in dentures does not lead to unpleasant sensations in the patient associated with galvanism [6].

Thermoplastic materials are high molecular weight substances that are superior to acrylic plastics in strength up to 20 times, moreover, they have greater elasticity, lower mass and lower porosity [7].

Thermoplastics used for the manufacture of dentures belong to various types of chemicals: polyamides, polyformaldehydes, polypropylenes and polymethylmethacrylates [8, 9].

Thermoinjection material take necessary shape under pressure up to 12 atmospheres, which is preserved after cooling of the prosthesis. This is possible due to the specific, linear, molecular structure of the substance.

When heated, intermolecular bonds in the material are weakened, as a result of which they are displaced relative to each other, the polymer softens and turns into a viscous liquid [10, 11].

The aim of our study was to study the physicochemical properties of structural materials used in dentistry.

Consider the groups of thermoinjection materials manufactured by various firms for denture bases (table 1).
Table 1. Distribution of thermoinjection materials used to manufacture removable denture bases depending on the chemical structure.

| Name of material | Group | Molecular mass (amu) | Manufacturing company |
|------------------|-------|----------------------|-----------------------|
| Flexi Nylon      | Polyamide | 15000 – 25000 | Perflex Ltd (Israel) |
| Valplast         | Polyamide |                | Valplast International Corp (USA) |
| DeFlex           | Polyamide |                | Nuxen (Argentina) |
| Thermosens       | Polyamide |                | Vertex (Holland) |
| DentalD          | Polyformaldehyde | 10000 – 30000 | Pressing Dental (San Marino) |
| Acetal Dental    | Polyformaldehyde | 75000 – 200000 | Acoplast (Israel) |
| Lipol            | Polypropylene |                | «Linos» (Ukraine) |
| FlexiteM.P.      | Polymethylmetacrylate | 80000 – 120000 | Flexite (USA) |
| Acry–Fry         | Polymethylmetacrylate |            | Perflex Ltd (Israel) |
| Ther.mmo.Free    | Polymethylmetacrylate |            | Perflex Ltd (Israel) |
| Fusicryl         | Polymethylmetacrylate |            | Quattro Ti (Italy) |

Material group "Polyamides". This group includes Flexite, Valplast, DeFlex, Thermosens materials, which are high molecular weight compounds whose main chain macromolecules have repeating amide groups. The internal structure is long interwoven threads [12].

Almost 90% of all polyamide materials on the market are elastic, or flexible thermoplastics. Semi-rigid and rigid thermoplastics, developed later to eliminate increased flexibility, account for 10%.

Soft Valamast polyamides are significantly lower than the standard in terms of modulus of elasticity and flexural strength. Therefore, dentures made of soft polyamides rely only on the gum and alveolar process. Classic partial removable laminar dentures distribute the load on the remaining teeth with the help of clasps, which reduces the load on the alveolar bone. A negative consequence of the construction of soft polyamides is the acceleration of atrophy of the alveolar ridge of the jaw.

When prosthetics of the included defects, rigid fixation of the denture is not required due to the absence of increased loads on the frontal group, or because of the small chewing surface in the lateral group. In this case, dentures made of soft polyamides that limit the defect can temporarily ensure an even redistribution of mastication pressure on the gums during function. Whereas with end defects, stable fixation of the denture cannot be achieved due to the high flexibility and elasticity of the material, therefore, dentures made of soft polyamides should be considered temporary [4].

In place of soft polyamide thermostaphastics, semi-rigid thermostaphastics appeared, such as Flexite Supreme, Flexi T, Flexi J, Flexi JP, DeFlex, Thermosens. Semi-rigid polyamides have a high modulus of elasticity, which distinguishes them from soft polyamides, giving them certain advantages. These dentures, due to their increased rigidity, evenly distribute the load throughout the denture, have good adhesion and retention. When applying the denture, the clasps open and close tightly, passing the equator of the tooth, thereby improving the fixation of the denture. Clasps made of semi-rigid polyamide do not stretch, unlike dentures made of elastic materials, due to this property, the denture can be used not as temporary, but as permanent. Due to the stiffness of the material, it is possible to simulate occlusal overlays, which take on a chewing load, unloading the mucous membrane of the alveolar process, as a result of which the prosthesis does not lead to rapid atrophy of bone tissue. Semi-rigid polyamides make it possible to construct a shortened sky during modeling. The constructions do not soften and do not balance during the patient’s intake of hot food, and do not react to a temperature of boiling water of 100 °C [13]. The minimum porosity of semi-rigid polyamides,
together with the maximum density, gives a low absorption capacity, providing a constant color of the denture.

Dentures made of semi-rigid polyamides are not deformed during processing, which allows to reach a mirror shine. Semi-rigid polyamides have the highest transparency, this allows the prosthesis to be thin, invisible in the oral cavity.

Polyformaldehyde (polyoxymethylenes, polymethylene oxide) group, materials: Dental D, T.S.M. Acetal Dental “,” Aceplast “. The molecular weight is 10,000 - 30,000 (amu).

Polyformaldehydes are synthetic resins, the most stable thermoplastics, which have a crystalline molecular structure comparable in strength to metal. Polyoxyethylene has a high fatigue resistance to chewing loads. It is a strong and resilient material.

Materials of this group are used for the manufacture of saddle clasp prostheses. Orthopedic constructions made of polyoxyethylene have greater rigidity, and high fatigue strength, wear resistance and moisture resistance. Polyoxyethylene material has a metal strength, but is more functional. Due to the flexibility of the prosthesis, the closest fit to the teeth limiting the defect occurs, thereby securing the prosthesis in the patient’s oral cavity.

Polyoxymethylene dentures are less felt by the patient, which is especially important during adaptation to dentures. Polyformaldehydedentures have a small volume; therefore, the shrinkage of the material is less noticeable. When dentures are made of white shades of polyoxyethylene, they achieve greater accuracy when pressed [8]. The absolute non-hygroscopic nature of this material prevents the penetration of bacteria and food particles into the thickness of the denture, thereby increasing the hygiene of the denture.

Standard clasps of all types and sizes can be made of polyoxyethylene plastic. Very elastic clasps are tightly fixed on the abutment teeth, allowing you to completely ignore the parallelometry and the use of the Ney clasp system.

Group of materials "Polypropylene", material: "Lipol". The average number molecular weight is 75,000 to 200,000 (amu).

Polypropylenes are synthetic non-polar thermoplastic polymers that belong to the class of polyolefins [11].

The structure of polypropylene practically does not differ from polyamides, and the indications for its use are similar. The main parameters of polypropylene are very similar to polyamides, but inferior to them in some physical and mechanical parameters. Polypropylene is characterized by high resistance to repeated bending, it has a relatively high impact strength, which increases with increasing molecular weight, while lowering the temperature, the resistance to shock decreases. Polypropylene prostheses have good wear resistance, similar to polyamides. Polypropylene "Lipol" is used for the production of partial removable dentures, as well as for the manufacture of removable splinting denture structures.

Polypropylene is notable for its increased impact strength, but its negative properties, such as poor polishability, insufficiently strong connection with artificial teeth, and thermolability, did not allow its widespread use in practice [14].

Material group “Polymethylmethacrylate (acrylopolymer)”, materials: "Flexite MR”, “Acry-free”, “Thermo Free”, “Fusicryl.”

"Polymethylmethacrylate" - has an amorphous structure, individual segments of the chain rotate independently of each other. The molecules are rounded in the form of tangles. The average molecular weight of polymethylmethacrylate used in dentistry is 80,000 - 120,000 (amu).

Polyoxymethacrylate, has found wide application in orthopedics for the production of bases of complete removable dentures. It is a thermoplastic which, in terms of aesthetics and adaptation to the prosthetic bed, far surpasses conventional monomeric acrylics due to its high elasticity. The advantages of thermoplastic acrylates are: the lack of monomer; increased elasticity; strength; the lack of volume reduction; minimum thickness and light weight; high esthetics due to the natural combination of the transparency of the material with the tissues of the prosthetic bed [8]. This material has practically no shrinkage, which means that it repeats the relief of gingival tissues as accurately as
possible. Due to its low elasticity, it is not flexible, therefore, it holds a denture well due to the preservation of the valve zone and the stability of the surface tension forces between the base of the denture and the mucous membrane.

Despite the fact that the bases of polymethylmethacrylate in their physicochemical and biological properties to a certain extent meet the requirements for basic materials, polymethyl methacrylate can cause pathological changes in the oral mucosa.

The use of elastic basic materials to manufacture dentures designs allows you to reduce masticatory pressure helping to slow down the processes of atrophy of the alveolar process (arcus dentalis), and reduces the time of adaptation to dentures.

Thus, when restoring the jaw adentia, taking into account the clinical situation in the patient’s oral cavity, it is necessary to select the base material taking into account physicochemical parameters.

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