PROSPECTS OF ESTABLISHING A TRABECULAR TANTAL IMPLANT BY THE ADDITIVE METHOD

Plotnikov S., Tyrlybekuly A., Myakinin A.[a], Kimossov R.

[1] East-Kazakhstan State Technical University named after D.Serikbayev, Ust-Kamenogorsk, Kazakhstan

[a]miakininsania@mail.ru

Introduction. Today, porous orthopedic implants reveal new horizons in skeletal reconstructive surgery, in the general replacement of the hip joint, recently called the "operation of the century" [1]. Until now, general arthroplasty of the hip joint has become a routine operation, when the treatment of hip osteoarthritis and the number of surgical interventions has been increasing since the 1970s. The most common causes for revision are mechanical weakening, infection and instability / dislocation [2]. Most of these failures are due to the wear of polyethylene and periprostheticosteolysis and, more recently, metallosis [1,3]. These defects of bone tissue need to be restored and filled during the revision operations with new structures on which new elements of the prosthesis are attached. These new structures can be autografts, polymethylmethacrylate (bone cement), or allografts. Currently, transplants are the best solution for creating a mechanical stable reconstruction that can withstand postoperative mechanical loading, in cases of large bone defects.

Purpose and subject of research. The purpose of this work is to determine the relevance of the development of technology for the production of trabecular tantalum implants by the additive method.

The first porous implants had only porous coatings of cobalt-chromium, but were soon replaced by the surgical type 5 Ti-6Al-4V, which is still the most widely used material for porous biomaterials [1]. An alternative with a large potential is tantalum (Ta). Ta is a solid, plastic, highly chemically resistant material with good biocompatibility to human bone. It has been used successfully as a biomaterial since the 1940s in clinical medicine, but because of its high cost and complexity in processing, the use of Ta as a biomaterial has been limited . Despite its promising biological properties, Ta is not considered to be a suitable material for large implants because of its high density and high price. Recent work devoted to research depending germination bone implant (trabecular implants are based on a porous alloy Ti-Nb-Ta, obtained by powder metallurgy techniques) showed a strong dependence on the alloy porosity and pore dimensions themselves. The best biocompatibility was shown by Ti-Nb-Ta based alloys with pore sizes from 200 to 400 μm, which correspond to the pore sizes of animals and human bones. The porosity of the alloy should be at least 70% with a plateau voltage of 53 MPa and an elastic modulus of 3.4 GPa

Results and discussion. The research team made an attempt to assess the competitive advantages of the proposed technology in comparison with the main market implants produced in the classical way.

A study of the endoprosthesis market showed that among the metals that are used for implantation, the proportion of titanium and its alloys that are best for implantology, in terms of biocompatibility and specific strength, is about 5%. This is due to the low processability of titanium, and, consequently, the high cost of implants, which are mainly manufactured by machining. In addition, the final finish of the bone-contacting surfaces is quite difficult.

The unique quality of tantalum is its high biological compatibility, i.e. The ability to get accustomed to the body without causing irritation to surrounding tissues. This property is based on the widespread use of tantalum in medicine, mainly in reconstructive surgery.

Tantalum has an advantage over titanium, stainless steel and other metals, which are used for the production of implants. Tantalum implants are more porous than titanium, which promotes bone growth and elasticity of the prosthesis itself.

However, only 5% of tantalum produced in the world is spent on medical needs, about 20% is consumed by the chemical industry. The bulk of tantalum - over 45% - goes to metallurgy. Leaders in the field of tantalum implants are the American company ZIMMER.

Tantalum production in East Kazakhstan is the only one in the CIS and one of the largest in the world, equipped with powerful modern equipment capable of processing any tantalum-niobium-containing raw materials into ingots, chips, powders, rolled products.

The use of tantalum in medicine will allow us to master a new segment, increasing the Kazakhstan content in the full cycle of production. The market of tantalum implants remains undeveloped due to various factors considered above. We are able to become the first in the market of modern implants to have a raw material base, a growing demand for endoprosthetics, and the use of new technologies in the production of implants. The combination of these factors will allow Kazakhstan to become a market leader with a fundamentally new approach to the production of medical products.

Conclusion. Unlike titanium, tantalum has a higher biocompatibility. Tantalum is a unique material - it has a high biological compatibility with the tissues of a living organism, without causing rejection, which is why it is widely used in medicine: reconstructive surgery, orthopedics. Tantalum plates cover the damaged skull, tantalum with alloys of other metals used to make endoprostheses.

Similar properties - biological compatibility - are alloys of tantalum with niobium. The lower density of alloys compared with tantalum makes them more promising in medicine, including implantology. The human body perceives tantalum not as a foreign body, but as its own bone tissue.

Increasing the share of medical use of tantalum will allow solving a wide range of tasks in traumatology, orthopedics and surgery. Diversified use of tantalum properties makes this metal a promising raw material in the future medicine. However, in the modern world there is no commercial application of tantalum implants obtained by the additive method, having scientific developments are at the stage of preclinical research.

The use of tantalum as a material in prototyping will allow:

• improve the efficiency of medical care, reduce the time of surgery and reduce risks to the patient;

• use tantalum raw materials in a completed production cycle;

• increase the share of Kazakhstan content in endoprosthetics.

References

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