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HISTORICAL ASPECTS AND PERSPECTIVES OF THE USE OF CAST MAGNESIUM ALLOYS FOR IMPLANTS IN MEDICINE

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There are considered a historical perspective and analysis of the use of different materials for implants in medicine. There are revealed positive influence and prospects of application biosoluble magnesium-based alloys for the manufacture of implants.

Keywords: implant, magnesium alloy, metalclamps, biocompatibility, biosolubility

Introduction. Yenrly in our country and abroad there is execute millions of surgical operations, connected with the use of metallic implants. Implants made from titan or steel traditionally use in medicine. Such long-life implant is foreign bodies which carry the strong risk for local inflammation. In addition, they complicate the processes of repair of organism and further treatment. In an order to avoid such negative effects, execute operations from moving away of implants. Such operations are very expensive and does not exclude the risk of the repeated surgical interferences, and also need extra-time for the repeated treatment.

Problem formulation. The purpose of work is a historical and analytical coverage of use of different materials for implants in medicine and study of possibility of application of biocompatible magnesium implants, able to dissolve in the organism of man.

Basic part of work. Application of metallic implants in medicine has more centenary history with beginning of making of steel constructions, covered by gold. To beginning of 30th of XX century carbon steel, which has coverage from a nickel, silver, gold, platinum, was considered the most eligible material for making metallic implants, without regard to a high cost, complication of technology of production, and also insufficient mechanical and anticorroding properties [1,2].

New alloys were created in 30th, many from which to present time are used for making of metallic implants of the different function, among which most widespread was prevailing steel XI8H9T. Availability of technology of production and treatments of steel promoted to wide its application in medicine [3]. However, the use of this steel has substantial defects, in particular, metalosis, which after putting of the metallic fixings from steel X18H9T arrives at 25.0-52.2 %, and corrosion of fixings (point and crack) presents 18-21 % [4]. At corrosions of the metallic fixings in surrounding fabrics the concentration of iron, chrome, nickel and titan grows. The protracted pres-

ence in the organism of man of implants from such steel results in the accumulation of toxic elements, in particular to the nickel, aluminum and chrome [5].

In 50th of past century implants were first applied, made from titan [6,7], which have a row of positive internals: high biological inertpass, corrosive durability and high mechanical properties. Titan has considerable corrosive durability, but it collapses in a hydrogen peroxide and in an alcohol, including to the alcoholtineture of iodine [8-10]. For the increase of mechanical durability and increase of corrosive durability of titan use it's alloying by different metals (zirconium, hafnium, tantalum, vanadium and niobium). However, high titanic alloys on the factors of biocompatibility, considerably worse technically clean titan. During their use the displays of allergic and natively irritable reactions of organism were marked. Except for that, alloying elements created unfavorable electrochemical reactions in an organism and influenced on biocompatibility with surrounding tissues [11]. Thus biocompatibility of implants from titanic alloys arrives due to application at biocompatible coverage's. Thus, application of expensive titanic alloys and also causing on the surface of products of coverage's, considerably promote the cost price of making of implants.

In the last years there is more attention spare to the problem of allergic reaction of organism on metallic implants, which shows up as aseptic inflammation. It is set that the most aseptic inflammation arises up at presence of alloying components of titan and stainless steel [12]. More expressed are allergic reactions at corrosions of metallic implants, when its products in form ions pass in surrounding tissueses those results in an eczema, neurodermatitiss, cuticles and other.

For today stainless steel and titanic alloys are basic materials for making of implants in surgery, but in the organism of man the noted materials are foreign bodies which carry the risk of local inflammation and rejection. In an order to avoid such negative effects the repeated operations from moving away of implants is executed. Such operations are very expensive and need additional time for further treatment. The decision of this problem is application of biocompatible implants, capable to dissolve in the organism of man.

The first biocompatible and biosoluble materials for implants were polymers (polyclicolic and polymilk acids), but mechanical properties of these materials limit their use. Polymers were the first biologically destroying materials which used for making of implants for an orthopaedy and traumatology [13,14]. Originally polymers divide into natural (squirrel, nucleic acids, and resins) and synthetic (polyethylene, polypropylene, phenol formaldehyde resins). At making of fixings for a traumatology there are use polyclicolic and polymilk acids. However such materials are fragile, weak on a laceration and have the very subzero module of resiliency cabin Yung. In this connection polymeric implants while did not get wide application in medicine.

At the end of 20th century works appeared about application of different types of ceramics for substituting for bone defects [15,16]. Basis of this type of ceramics were hydroxyappatite and tricalciumphasphate, which are integrated with bone tissuese, creating a difficult mineral-protein-cellular complex. Thus the construction of new tissuese reminds the mechanism of remodeling of bone in a great deal. However

the main obstacle of wide use of calcium- phosphatic ceramics for making of the different fixings is insignificant mechanical durability of such type of implants.

By perspective biocompatible material for the production of biosoluble implants there can be alloys on the basis of magnesium [17]. Magnesium is the characteristic element of Earth mantle. Natural magnesium consists of three stable isotopes and shows by elf the easy alkaline-each metal of white color. In an organism magnesium is contained mainly as salts (in the serum of blood, red corpuscles, skeleton). The Organ-depot of magnesium is bones [18]. Magnesium is a major infiacellur element, its content in cages on many times exceeds content in a ultracellur liquid and participates in exchange processes, closely co-operating with potassium, sodium, calcium, is an activator for the great number quantity of enzymatic reactions [19,20], and also enters in the complement of many enzymatic systems which participate in exchange processes, that explains its large meaningfulness for an organism.

A normal level of magnesium in an organism is a necessity for providing of "energy" vitally important processes, adjusting of nervy-muscular conductivity, tone of smooth musculature (vessels, bowels, bilious and urinary bubble) [19,20]. Magnesium plays an important role in many fundamental cellular reactions, that the deficit of its can result in serious biochemical and clinical treasons. Magnesium is known as an antistress bioelement, capable to create a positive psychological mood and strengthen the immune system, it has an antiunrhythmical action and assists in proceeding forces after the physical loading. It is develops depression at the lacks of magnesium, it is energy muscular weakness; there is propensity to the convulsive states [17].

There is an about 140 g of magnesium (0.2 % from mass of body) in the organism of the grown man. Day's necessity of the noted element for a man is estimated by the different authors of from 400 to 500 mg. Magnesium for a man is untoxic, it’s a lethal dose is not certain [20].

Magnesium and products of its corrosion have excellent biological compatibility [18]. Insufficient mechanical properties of magnesium and also very rapid biological corrosion after implantation in a living organism remain by problem.

Property of metallic magnesium to dissolve in tissueses of living organism was known yet at the beginning XX century. Beginning from this period, executing clinical tests on animals at various surgical operations [21], it is set that metallic magnesium fully resolves in soft tissueses of animals without visible pathological influence on an organism [22]. After it the test of various constructions (pins, plates, wires) from magnesium begins for surgery on a man and possibility of complete dissolution is set magnesium to the implant without damages for an organism. But the use of implants from clean magnesium has a substantial defect is rapid solubility and subzero mechanical properties of material. Taking into account these problem efforts of researchers was directed for development of the alloyed and modified alloys on the basis of metallic magnesium with the increased corrosive durability and physics-mechanical properties. In 1937 the first information appears about application of fixings from a magnesium alloy (92 % Mg, 8 % Al), executed as bails and serums at the breaks of bones [18]. In 1940 the test of alloy on the basis of magnesium «electron»

for osteosynthesis of bones is executed [23], and already in 1956 the whole series of operations are carried out on animals with application of different magnesium alloys. In XXI century magnesium is again in the center of the increased attention from its unique combination of mechanical, physical and biological properties. Magnesium alloys were offered as material for making of biodegrading implants through their kind biocompatibility and module of resiliency, what near to bone tissuese. And their capacity for biodegradation allows to avoid the repeated operation from moving away of implants.

Magnesium and products of its corrosion have excellent biocompatibility. Many researches testify to positive influence of products of biodegradation of magnesium on the organism of man, but the mechanism of their action does not while clear [22]. According to one of theories on the surface of such material from biological surroundings albumens which stimulate the increase of bone cages and process of cicatrisation are adsorbed certain. There are considered that such co-operation assists forming of direct chemical connections between a magnesium implant and mineral phase of neogenic bone tissuese [23].

Magnesium alloys are easy at weight and, due to the descriptions of durability, is suitable for making of implants of different types. Considerable interest elasticity of magnesium alloys causes, in fact bone, as living tissuese, constantly remodulate under tension and this process can result in a break to the implant. Initial inflexibility of cortical layer of bone presents 20-40 GPa. For an example, module of inflexibility for non-rusting steels is about 200 GPa, for titanic alloys is almost 115 GPa. Magnesium alloys, have the module of elasticity about is 45 GPa [24]. For today at the market a few types of commercial alloys on the basis of magnesium, which have alike biocorrosive and mechanical characteristics, are presented: ML5 and ML10 in domestic industry and AZ91A, AZ91B, AZ91C, AZ91D, AZ91E, LAE442, WE43 in the world market. In experiments there are most often use the alloy of zirconium and magnesium (AZ91), alloy of magnesium and calcium (LAE442) [24].

Basic direction of modern researches is controlling of speed of biodegradation of magnesium alloys [25,26], determination of influence of products of biodegradation of magnesium alloys on the organism of man [27], and also co-operation of surface magnesium implant with bone tissuese [28]. The study of possible toxic, mutagen and allergic action of products of biodegradation of magnesium alloys is carried out [29,30].

Researches showed that for a magnesium alloy more stable is a contact of surface to the implant with bone tissuese, than for bioinert implants. Scientific researches showed absence of negative influence of ions of magnesium on the organism of man [30], and some researchers specify even on their positive influence on forming of bone tissuese. In the process of research of toxic influence of products of biodegradation of alloy of magnesium with zinc, manganese and niobium it was not educed substantial differences for the control groups of animals in the biochemical factors of blood and urine [28,31].

Without regard to those researchers spare more attention magnesium alloys in industry of biomaterials there are problems which complicate the wide use of metallic

magnesium and its alloys in medicine. It is insufficient physics and mechanical properties of magnesium alloys, absence of possibility of management by speed of biocorrosion of magnesium implants. In fact an implant must have sufficient durability and corrosive durability on the necessary period of time, that the union of bones took place during breaks.

Conclusions. Magnesium alloys are perspective material for making of different types of implants for medicine. As an analysis of the advanced studies for the last decades shows, amount of the articles, sacred to the study properties of alloys on the basis of magnesium and them bio(dis)solubility, grew considerably. Numerous experiments showed on animals, that these alloys had good biocompatibility and sufficient corrosive durability, and also module of resiliency cabin Yung which is maximally close to the module of resiliency of cortical layer of bone. Mechanical properties of magnesium alloys enable making of different metalfixators (screws, plates, nails, and porous metallic matrixs). Implants basis of which is magnesium have a row of advantages above the bioinert alloys of metals, polymers and bioceramics. They are not toxic, are not carcinogenic, on mechanical properties are more close to the structure of cortical layer of bone and characterized by an antibacterial action. Also a necessity for the repeated surgical interference which has a large social and pertaining to national economy value falls off.

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