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THE DEGRADATION OF METAL IMPLANTS

ABSTRACT

The presence of metal implants in the human body causes some dangers, which result from introducing another object into organism. There may occur a biocorrosion, which causes different modifications of implant surface.

Key words: *degradation, metal implants*

INTRODUCTION

Degradation of materials depends on their properties, environment and anathomic placement. Formation of degradation products is connected with the change of quantity of the material, releasing surface layer compounds, cracking of construction and separation and migration of compounds from one material to another in multi-compound products [1].

Little resistance of material to wear out through friction as well as stimulating immunity process results in forming osteoclasts, the cells responsible for resorption of bones around the implant, which in turn is the cause of loosing the endoprothesis made of titanium alloys [2].

The presence of biomaterials in a body always results in formation of immunity area. Destruction of soft tissue and bones accompanies the introducing implant, intensifies immunity reaction, even without infectous factors. In case of the joint endoprothesis the bits of the material formed while friction, especially of the oxygen layer, gather in the area of biomaterial-tissue, which releases immunity reaction and couses the destruction of bone tissue by osteoclasts. As a result pathological changes in cartilage and bone occur [3].

The environment of a living thing usually contains sodium and chloride cations, carbon and phosphorus dioxides and organic acid. In biological complex environment implanted metals or their alloys may undergo degradation and the products resulting from the process may be dangerous [4-6].

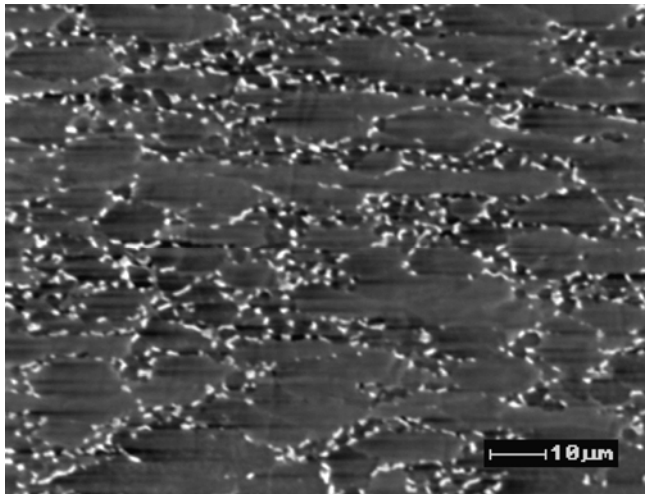
The aim of the article is showing the problems connected with the degradation of metal implants. The article presents some implant items after removing them from human body.

EXPERIMENTAL

Two endoprothesis made of alloy steel - Ti6Al4V (pic.1). The chemical composition was as follows: Ti, 4,08%V, 6,39%Al, 0,17%Fe, 0,015%C, 0,185%O, 0,005%N, 0,0035%H

Pic.1. The endoprothesis made of titanium alloy (Ti-6Al-4V)

The research was carried out by using the scanning electron microscopy (SEM) (pic.2), it showed that the microstructure of Ti-6Al-4V consists of phasal combination (α+β).

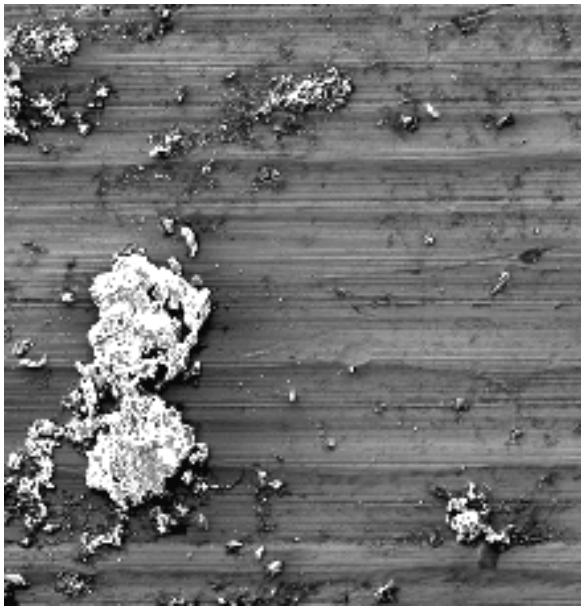


Pic.2. The view of Ti-6Al-4V structure

Those were endoprothesis of two men. First one aged 59 (had his endoprothesis planted in 1991 and removed in 2003). The other patient aged 65 (had his endoprothesis planted in 1997 and removed in 2005). In both cases aseptic loosing was the reason for removal.

RESULTS

The microscopic analyses of surface layer showed the presence of *Staphylococcus Epidermidis* (pic.3). It is considered to be skin bacteria flora. It can enter the body, when balance between immunity and bacterial systems is broken, causing inflammation of soft tissue and organs. *Staphylococcus Epidermidis* is capable of producing phlegm, which makes sticking different objects like prothesis possible. The produced phlegm deteriorates immunological functioning as well as proper absorption of antibiotics in the infected area.



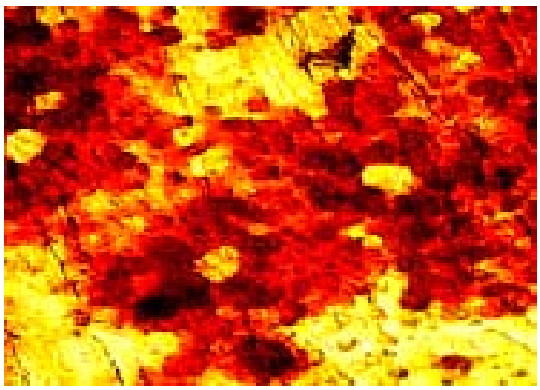
Pic.3. The view of *Staphylococcus Epidermidis*

Picture 4 and 5 show degraded implants, after removed of human body.

Pic.4. The degraded implants from the first patient

Pic.5. The degraded implants from the second patient

After careful examination of the implant surface (under the focus bacteria) it turned out that the spots had undergone biocorrosion. The bacteria consumed the surface they had been on forming so called pitting corrosion (pic.6).



Pic.6. Pitting corrosion on Ti-6Al-4V (SEM)

DISCUSSION

In bone surgeries the most frequent implants are made of metal. For the living thing metal is a strange object from which it separates by means of a fibra tissue, reaching up to a few millimeters. The fibra tissue formed around the metal not always undergo the process of calcification. Hence frequent loosening of implants. Mechanical irritation causes occurance of prolonged inflammation process close to the implant [1].

CONCLUSION

1. The reason for removing implants was their degradation caused by improper conditions provided by the body – both patients suffered from *Poliarthritis Rheumatoidea*.
2. The bacteria *Staphylococcus Epidermidis* as well as the environment of the body

liquids caused pitts in the material. Under the bacteria biofilm there appeared a pitting corrosion.

LITERATURE

1. Biocybernetics and Biomedical Engineering 2000. Biomaterials IV T. PAN, [red.] M. Nałęcz, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2003.
2. Jonas L., Fulda G., Radeck R.: Biodegradation of titanium implants after long-time insertion used for the treatment of fractured upper and lower jaws through osteosynthesis: Elemental analysis by electron microscopy and EDX or EELS. Ultrastr. Pathol. 25 (2001) 375.
3. Thompson G.J., Puelo D.A.: Ti6Al4V ion solution inhibition of osteogenic cell phenotype as function of differentiation time-course in vitro. Biomaterials 17 (1996) 1949.
4. Liebhard J., Kuś H., Martosz M., Rutowski R., Małolepszy J., Obojski A., Medrala W.: Allergy to nikel, chromium and kobalt after joining the bones by means of metal joints. Pol. Merk. Lek. 2000, 8, 47, 316.
5. Lundeen G.A., Shea K.G., Sanderson C., Bachus K., Bloebaum R.D.: Technique for identification of submicron metal particulate from implants in histological specimens J. Biomed. Mater. Res., 1998, 43 (2), 168-174.
6. Morais S., Sousa J.P., Fermande M.H., Carvalho G.S., Bruijn J.D., van Blitterswijk C.A.: Effects of AISI 316L corrosion products in in vitro bone formation. Biomaterials, 1998, 19 (11-12), 999-1007.