NORTH UNIVERSITY OF BAIA MARE

SCIENTIFIC BULLETIN

Serie C, Volume XI

Fascicle: Mechanics, Tribology,
Machine Building Technology

INTERNATIONAL MULTIDISCIPLINARY CONFERENCE

2ND EDITION

- PAPERS -

November 28-29th, 1997

BAIA MARE
1997

COMPARATIVE CHARACTERISTICS OF THE PROCESS OF STEOINTEGRATION OF IMPLANTS WITH BIOACTIVE COATINGS

A.Potapchuk, J.Sharkany, I.Gorzov, M.Sichka

Uzhgorod State University, Ukraine

The modern development of stomatological implantology is based on the wide application of new achievements in the field of material science and technical physics, technology of sawing of bioinert and bioactive materials, and on the results of investigation of the implant interaction with surrounding tissues.

One of the serious complications in implantology is metallosis and instability of the implant. Many investigators see the solving of this problem in the way of isolation of the metal construction from the recipient tissues by means of plotting a bioactive ceramic material on the surface of the implant.

That is why the improvement of existing materials and elaboration of new technologies of bioactive coverings sawings on the implant, and using different compositions on the basis of hydroxyapatite (HA) are very actual.

In order to accelerate the processes of osteointegration of metal implants they are covered by ceramic biocompatible HA coating. Usially for the plotting of the powder is used the method of plasma spray [1]. The structure of plasma coatings of HA on the metal underlayers significantly depends on their thickness [2-4]. The inner layers, which are more close to the metal base contain more amorphous and small-cristalline phase than the external layers. It is known that the amorphous phase of HA structure in the process of osteointegration more quikly resobses in the organism.

It is the reason for further scaling on the butt of metal and bioactive coating and disturbances of the implant retension in the bone, worsening the remoted results of prosthesis.

Using pure biologically active materials of HA type is limited by the fact that these materials can not provide necessary strength characteristics, and loadings of the implant [5,6]. That is why it is actual to create bioactive film coatings on the metal implants which have high mechanical features.

We have worked out a special method of receiving gradient coatings on the basis of bioactive HA and inert Al2O3 with determined distribution of concentration of these compounds [7]. Performed investigations of the structure, morphology and mechanical features of the created coatings prove the perspectiveness of their application in implantology.

The main aim of the present investigation is to study in the conditions of experiment the peculiarities of bone tissue reconstruction around titanium implants with different ceramic coatings.

MATERIALS AND METHODS.

For sawing the coverings we used a powder of aluminium oxide with average size of particles 60 mcm and the powder of HA ("KERHAP") with mean size of particles 80 mcm, which was synthesized in the Scientific Research Institute of material Science of Ukainian Academy of Sciences. Diffractogramms of this powder revealed the presence of characteristic reflection spectra of HA

In a role of sublayers we used titanium plates, the surface of which was polished, worked up by sand-blast mashine and directly before sawing was clarified according to the standard method [8].

Sawing has been performed using a modified apparatus of plasma spray in which the powder was introduced into the plasma through apertures on the anod. The worked out delivering system allows to receive one-layered, two-layered and gradient coatings with determined distribution of compounds (Al2O3 and HA) along the thickness of the coating. Gradient distribution of inert Al2O3 and bioactive component (HA) was provided by means of determined feeding of base powders into the plasma according to their termophysical characteristics. The thickness of coatings was about 200 mcm. Complex of investigations of mechanical features of the received coverings included measuring of adhesia by means of normal tearing

off method, microsolidity - by means of pressing of diamond piramide into the surface of coatings with a strength of 2 N during 10 s (using apparatus PMT-3), porosity - by means of hydrostatical measuring method.

RESULTS AND DISCUSSION.

The results of measuring of mechanical features and porosity of received coatings for different structures (one-layered - Al2O3 and HA, two-layered and gradient) are presented in the Table.

Sample	Adhesia	Microsolidity	Porosity
-	Mpa	Mpa	%
Al_2O_3	42	20500	10,6
HA	22	12600	4,9
Al_2O_3-HA	37	17500	11,8
Al_2O_3-HA	35	18000	13,3

Presented results prove, that the values af adhesia and microsolidity in one-layered HA coverings are much more lower in comparison with two-layered and gradient coverings on basis of Al2O3-HA. Performed measurings showed that the value of adhesia did not depend on the distribution of components (Al2O3) across the thickness of the coating because the strength of coupling of the coating with titanium sublayer are determined by lower layers of the gradient covering, which are composed mainly of Al2O3.

Thus the received two-layered and gradient coatings according to their mechanical features are significantly better than one-layered on the basis of HA.

In experiment on rabbits, processes of osteogenesis and osseointegration after after implantation of dental titanium implants, being coated with alumina ceramics and HA, into the distal epiphysis of the femur were studied. Structure of these coatings was different - gradient, bilayered and composite compounds. It was revealed that on the 14th day a larger part of the implants surface with gradient and bilayered coatings was surrounded by osteogenic tissue with areas of newly-formed trabeculae. In some areas near the implants there were small bone sequesters. Around the implants coated with a mixture of ceramic materials, there was a newly-formed bone too, but only in small areas, and closely to the implant there was a collagenofibrous connective tissue. The highest osteogenetic activity was around the implants with a gradient coating.

On the 30th day, an intimate contact of newly-formed trabeculae of the bone tissue with the implant surface was revealed. In such areas, osteoblasts were localised on the very material of the coating. The length of contacting areas of the trabeculae with investigated coatings of implants was different.

On the 60th day the whole surface of implants with a gradient coating was surrounded by a spongy bone, with intimate contact of bone trabeculae with the coating material on the larger part of the coating surface. On the contrary, near implants with a bilayered coating, and particularly with a mixed (Al2O3-HA) ceramic one, there were small areas of the connective tissue with significantly less length of an intimate contact between a newly formed bone and the coating material.

Thus, the processes of osteogenesis and osseointegration with the bone tissue are more intensive around implants with a gradient ceramic coating.

The whole comlex of received results proved that the better and repspective coating among all investigated materials is the gradient ceramic coating.

BIBLIOGRAPHY

[1]. Kay J. F., Goles T.S., Riley R.L. J Prosthet Dent 1987; 58:339.
[2]. Z. Zyman, J. Weng, X. Liu, X. Zhang, Z. Ma. Biomaterials 1993, Vol. 14, No. 3, p. 225.
[3]. Z. Zyman, Y. Cao, X. Zhang. Biomaterials 1993, Vol. 14, No. 15, p. 1140.
[4]. Z. Zyman, J.Weng, X. Liu, X. Li, X. Zhang. Biomaterials 1994, Vol. 15, No. 2, p. 151.
[5] Denissen H. W., Kalk W. , de Nievport H.M. et al. J J P 1990; 3: 1: 53-58.
[6] Morimoto K., Kihara A., Takeshita F. at al. J Oral Implant 1987; 13: 3: 387 - 400.
[7] A. Potapchuk, J. Sharkany, I. Horzov, E. Gavrik. Tooth implant, Patent of Ukraine, N 17590 A
[8] Standard Recommended Practice for Descaling and Cleaning Titanum and Titanum Alloy Surfaces. Designation B600-74, ASTM Committee on Standards, Philadelphia, PA, USA, 1974 559-671.