than for the variant (ii). In terms of the surgical procedure, the basic conclusions which could assist the clinician are as follows. To avoid the distortion of the spectrum of natural frequencies:

1) the perforation of the stapes footplate should be performed in the places where its thickness is minimum;

2) the shape of perforation in the footplate should be done in such a way that the prosthesis shaft had the maximum freedom.

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BIOMECHANICAL ASSESSMENT OF THE BONE INGROWTH EFFECT DURING CEMENTLESS ENDOPROSTHESIS OSSEOINTEGRATION

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Introduction. Total hip replacement despite of its complexity and possible complications takes a leading place in the surgical treatment of the patients with severe diseases of the hip joint. The goal of such treatment is to replace the damaged joint with artificial junction in purpose to restore initial mobility and release pain. During this procedure acetabulum of the hip is substituted by the cup and proximal part of the thigh is substituted by the femoral stem with femoral head. Depending on the type of fixation within the bone implants could be separated into two main groups: cemented and cementless prostheses.

Due to excellent biocompatibility and high strength properties along with a light weight one of most common material used in cementless prosthesis is titanium. To increase biological integration of the implant manufacturers make its surface rough or cover it with the porous structure. Presence of the interconnected pores within the volume of prosthesis provokes formation of the blood vessels and subsequently bone tissue ingrowth. This biological effect is known as osseointegration process. Established bond helps to reduce so called stress-shielding effect caused by the mismatch in the young's modulus of the bone (17GPa for compact bone) and prosthesis material (110GPa for titanium). Extended region of the bone-implant interface uniformly transmits stresses to the surrounded tissues avoiding formation of the contact areas subjected to exceeded loads as well as creation of unloaded areas.

There are many different approaches and methodologies describing complex and irregular shape of cellular materials [1]. However, analytical and numerical models usually represent idealistic assumption of the real three-dimensional object or review its simplified two-dimensional version [2]. One of the novel techniques used to investigate structure of the porous material based on X-ray tomography and direct finite element modeling. This non-destructive method is used for investigation of possible damages under compressive load primary to mechanical tests [3]. Another challenging problem to be investigated is mechanical behavior of the porous titanium after completed process of osseointegration when all pores inside the volume are filled by bone tissue. In this research creation of FEM models of prospective biocomposite bone/porous titanium is examined and methodology is describes.

Materials and methods. For this study commercial porous titanium structure produced by the powder metallurgy was supplied by JSC «Altimed» (Minsk, Belarus). Shape of manufactured specimen entirely repeats the geometry of proximal part of existing cementless femoral stem. Originally, this stem has two inserts made of porous titanium. Due to very good results of bone tissues ingrowth it was decided to enlarge porous area of the implant.

To create three-dimensional model of the new porous titanium structure, specimen was placed in the work area of X-ray tomography apparatus. During full 360 degree rotation emission radiation passed through the object was absorbed and digitally recorded. Resulting data from radiograph were processed by software and series of axial slices are generated. Based on obtained two-dimensional images of the internal topology of specimen, three-dimensional image was reconstructed composed of certain number of voxels (3D-pixels). These data were used for reconstruction of the finite element model that represents porous structure of the investigated cellular Ti specimen. For that purpose, all axial slices were masked using proper software and set of voxels belonging to the metallic material are extracted from entire volume. Afterwards voxels were rendered as the clouds of points which could be connected with each other to form a triangle mesh. These data is possible to export in STL file format and with assistance of finite element analysis program ABAQUS translate into final 3D solid model. A high quality mesh consisting of quadratic 10-nodes tetrahedrons (C3D10) was built over the volume of Ti porous structure.

Another finite element model represented the same Ti porous structure described above but all pores inside the volume were modeled as bone tissues. For that purpose all voxels remained after extraction of metallic part of the volumetric image were also translated into 3D solid model. Young's modulus of the titanium and bone tissues was determined as 110GPa and 17GPa respectively. Boundary conditions were applied to FE analysis of both models, keeping the one side of the model fixed, while applying on the opposite side axial displacement along z-axis, thus exerting compression load on the model.

Results. The calculated stress distribution within the Ti porous structure showed that maximum values are experienced by the struts oriented parallel to the load direction, where consequently crack propagation is occurred. Detailed observation of the results highlighted that possible fracture of scaffold located close to the node of the cell. Inclusion into the finite element model bone tissues had strengthened the initial properties of the specimen. Based on the calculated results could be conclude that osseointegration process has a positive influence on mechanical properties of the Ti porous structure and extended ingrowth area of the stem enhance implant stability.

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SELF-REGULATING SYNERGETIC MODEL OF THE CARDIOVASCULAR SYSTEM

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The study of the processes that occur during the blood flow in the vessels – an important task as its analysis can help with the treatment and prognosis of various diseases of the cardiovascular system. A number of hydrodynamic, physical, physiological factors influence the blood flow in a vessel. Therefore during the study and the analysis of the processes that occur in the bloodstream there is a need to take into account in mathematical models the processes happening in a wall of a vessel, on border "a vessel wall – blood", and also rheological properties of the blood [1]. The important property of the cardiovascular system performance is ability of heart to adapt to changing of the organism demand for the blood supply, that caused by a condition of the organism and conditions in which the organism is. This property is realized by the regulatory mechanisms, that are presented as intracardiac, and ekstracardiac (nervous, humoral) influences, and as influence at the level of cells and as the intercellular interaction in the heart.

The equations that describes the dependence between the pressure of the blood and the radius of a vessel taking into account the ability of the heart to self-regulation, mechanical properties of a vessel and the external forces action (for example, a blood pressure) are received in study.

On the basis of the Navier–Stokes equations (1) the model of a screw-like