

EXPERIMENTAL METHODS APPLIED IN THE DEVELOPMENT OF HUMAN SKELETAL IMPLANTS IN CZECH REPUBLIC

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INTRODUCTION: The contribution deals with application of the experimental methods and progressive technologies applied for the development of skeletal implants in Laboratory of Biomechanics of Man at the Czech Technical University in Prague. The final product created in the laboratory can be 3D model made by the Fused Deposition Modeling (FDM) technology from ABS plastic material together with analysis by means of the finite element method (FEM). There is the experimental equipment necessary for the mechanical testing of materials and components of implants. Laboratory has the straight connection to the Czech producers of implants so the research results are applied in industry.

METHODS: For the mechanical testing is used MTS 858 Mini Bionix testing system that enables to run various tests to obtain basic material characteristics, wear and fatigue properties. At present the system is used for the testing of wear resistance for the various combinations of materials including Zirconia ceramics, Vitalium and UHMWPE. The other tests are concentrated on biaxial flexural strength of Zirconia ceramics. For the manufacturing of 3D models is used Fused Deposition Modelling Rapid Prototyping technology and machine type Stratasys FDM 1650. Models are created layer by layer from ABS plastic material and it is possible to machine them and modify to meet customer requirements. The first step of the manufacturing process is the processing of data files. Mostly 3D computer model in CAD format are used as the data source but there can be used also computer numerical control (CNC) milling machine as the scanner for digitizing of physical objects. Combining CAD software Unigraphics and Desk Artes Rapid Tools, the number of possible errors in computer model is minimized. Then the same computer model is applied for the manufacturing as well as finite element analysis.

RESULTS: There were carried out first sets of experiments on MTS system. The capability of the system is sufficient and it is possible to comply with requirements according to standards. Results show advantages of application Zirconia ceramics in prosthetics from the mechanical properties point of view. Czech producers use models made by FDM for the manufacturing of the new type of femoral component of the total knee prosthesis. First femoral components made of Zirconia ceramics were implanted into patients. FDM technology was applied in the development of bioelectronic hand prosthesis for the manufacturing of functional prototypes.

CONCLUSIONS: The results shows that the process of creating skeletal implants is highly accelerated by using RP technology together with mechanical testing system and other tools for theoretical analyses necessary for the development of new products. There are big differences in comparison with EU countries. This kind of research must be funded mostly from government and non-commercial sources. It is still very expensive for industrial companies and health service establishment. There has been started research in the field of custom made skeletal implants in Laboratory of Biomechanics of Man. This research includes study, description and mathematical modelling of bones as well as the programming of the software tools for the CT images processing.

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