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EXAMINATION OF THE BIG JOINT PROSTHESIS

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Abstract: The hip joint arthrosis is one of the most common musculoskeletal disease and its occurrence is so common that almost everyone has heard of it or met someone who was operated on due to this disease [6]. Currently the lifetime of the prosthesis is approximately 10 years [1]. Unfortunately, prosthesis loosens beyond this period, thus replacement is needed. In this paper we present the geometric construction, modelling and Finite Element Analysis of the hip-joint prosthesis.
Keywords: hip joint, prosthesis, modelling, Finite Element Analysis

INTRODUCTION - THE HIPS

The hip joint (Fig.1.) is one of the largest joints in the human body and is what is known as a 'ball and socket joint'.

In a healthy hip joint, the bones are connected to each other with bands of tissue known as ligaments. These ligaments are lubricated with fluid to reduce friction.

Joints are also surrounded by a type of tissue called cartilage that is designed to help support the joints and prevent bones from rubbing against each other.

The main purpose of the hip joints is to support the upper body when a person is standing, walking and running, and to help with certain movements, such as bending and stretching. [7]

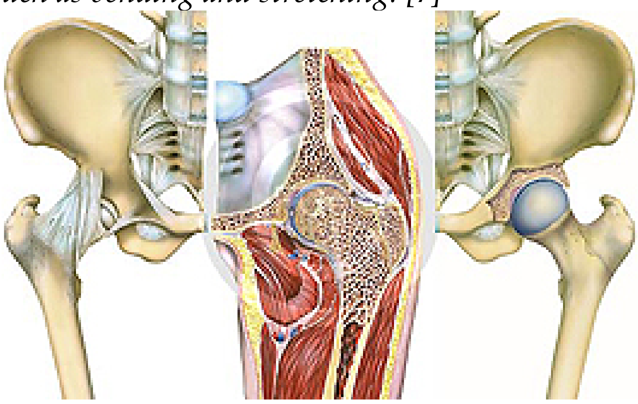

Figure 1. Hip joint [8]

PARTS OF THE HIP PROSTHESIS

The anatomic hip prosthesis may be cemented and cementless depending on the type of fixation used to hold the implant in place.

Construction (Figure 2):

- socket;
- metal head;
- metal stem of different types.

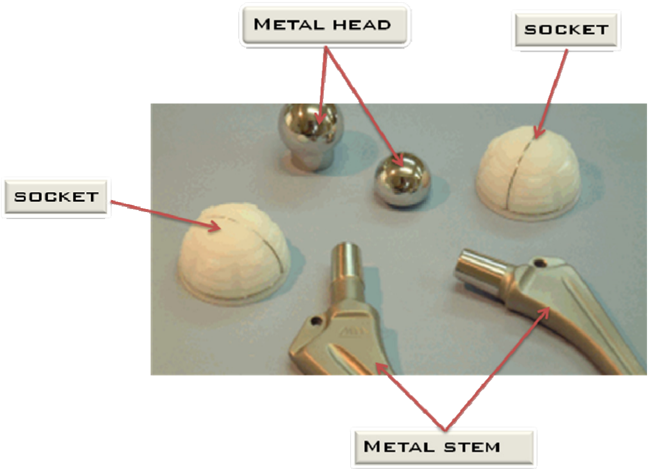

Figure 2. Parts of hip joint prosthesis

THE MEASUREMENT OF THE SOCKET

We measured with 3D measuring machine The measurement happens in the coordinate system defined by the planner and the equipment. It is one of the main characteristics of the CMM that under normal circumstances, it records the features to be examined point by point on the surface of the workpiece.

The concept of the point by point analysis gives the CMM universal usability; thus, all metrological problems that can be described mathematically, can be solved in practice with help of it.

We fixed the measurement data and drew the curves with the help of PC_DMIS software (Figure 3). This program translates the top level commands into a form that makes it possible to control the Coordinate Measuring Machine. It is an advantage for the user, that he can start the measurement with the familiar drop-down menus, windows, dialogue boxes and icons. The variability of the user's surface of the PC-DMIS simplifies customization, so the user may apply his personal settings in the software, which yields more comfortable and more efficient work.

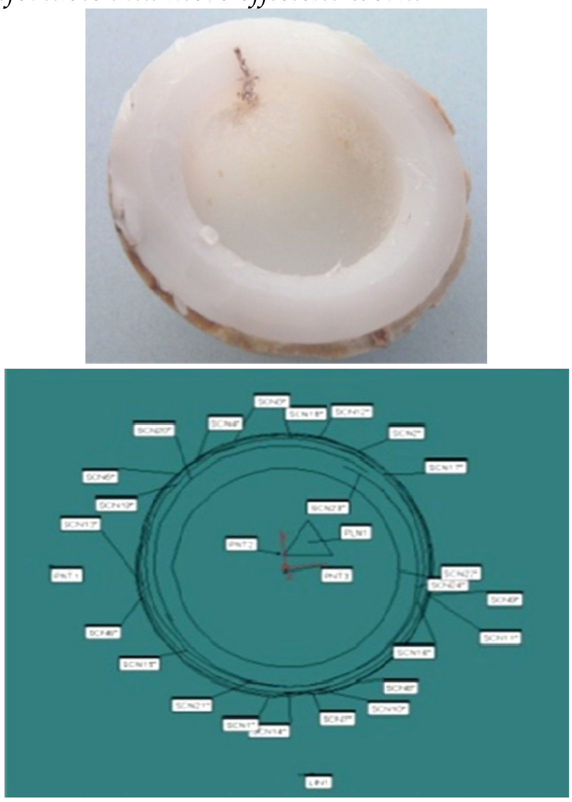

Figure 3. Picture of the measured socket and graphical representation

RECONTRUCTION OF THE MEASUREMENT POINTS

The reconstruction of the measurement points happened with the help of several types of 3D design software. We drew and analysed the measured points with CAD software (for example AutoCAD).

Steps:

- *entering the measurement points into the software (entering the coordinates into the AutoCAD software);*
- *drawing the contour lines;*
- *drawing the Hermite - sheets;*
- *turning the curves (around the rotation axis) (Figure 4);*
- *drawing the differences (Figure 5).*

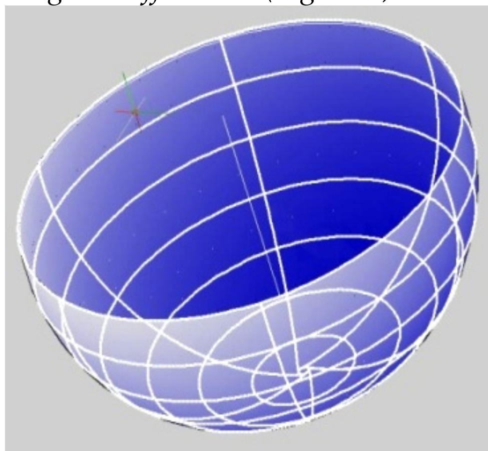

Figure 4. Drawing the surface

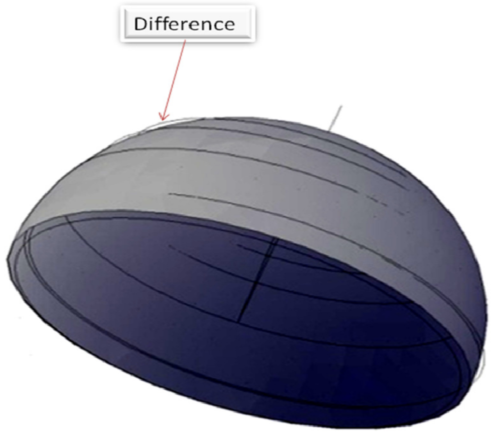

Figure 5. Difference of the theoretical and real surface

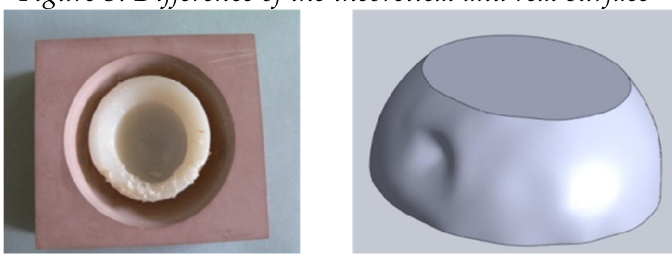

Figure 6. The measured socket and model of the socket, drew the CAD

After the theoretical surface we drew the real surfaces, on which the distortions, bulging and buckling are clearly visible. On the figures below examples of the measured sockets can be seen (Figure 6).

MODELLING

For creating the 3D model of the sphere head and the socket (Figure 7) we used the results of the 3D measurement of the "etalon" socket and the data appearing in the specifications of the sphere head and the socket. We used the Solid Edge planning software to do the planning as the 3D model *formed in this way can be used in the research with the FEM software.*

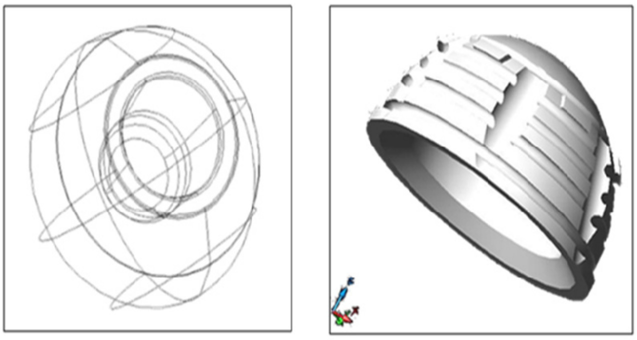

Figure 7. Model of the head and socket

FINITE ELEMENTS METHOD ANALYSIS

The FEM analysis is executed with the help of the so called ANSYS FEM software [3,5].

Introduction of the ANSYS FEM analysis software

The ANSYS Workbench is the framework upon which the industry's broadest suite of advanced engineering simulation technology is built. An innovative project schematic view ties together the entire simulation process, guiding the user through even complex multiphysics analyses with drag-and-drop simplicity. With bidirectional CAD connectivity, an automated project update mechanism, pervasive parameter management and integrated optimization tools, the ANSYS Workbench platform delivers unprecedented productivity that truly enables Simulation Driven Product Development.

The test was made in two different ways:

1. *First we put the sphere head and the socket in each other and some force was applied towards the centre (Figure 8). After the test we analysed the findings separately for the sphere head and the socket (Figures 9 and 10).*

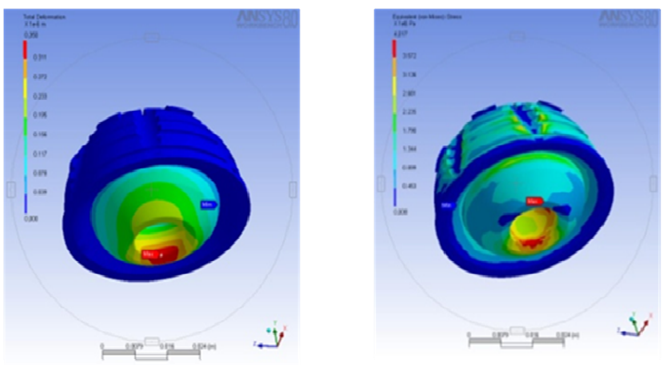

Figure 8. The analysis of tenseness and deformation, in a complex state

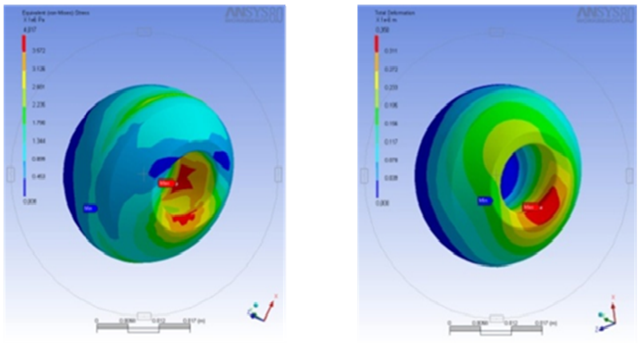

Figure 9. The analysis of tenseness and deformation on the head

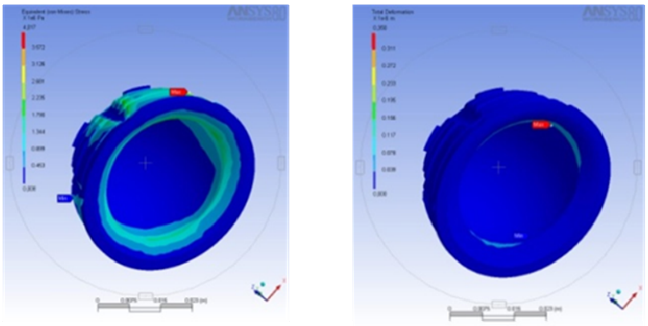

Figure 10. The analysis of tenseness and deformation on the socket

2. *In the second stage we applied the torque to the system and we examined tension and values of deformation (Figures 11).*

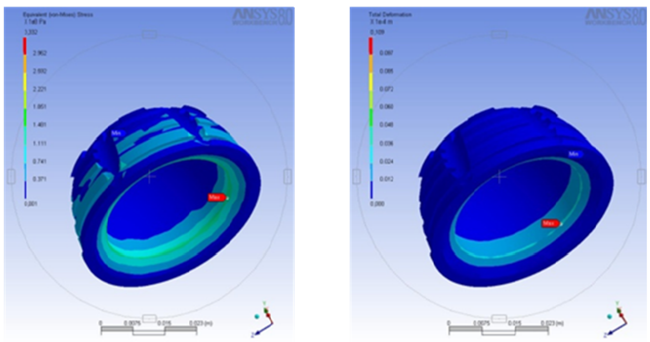

Figure 11. The analysis of tenseness and deformation on the socket

SUMMARY

I presented the elements of the hip-joint prosthesis. Within that however I dealt with the socket in detail. I checked the socket, which is removed from some patient with the help of 3D measuring machine. I covered about the measured data and I reconstructed co-ordinates with the help of different software with computer aided design. From these I received a theoretical surface and the exact and deformed surface.

I drew the 3D model of the head and socket with the help of the Solid Edge designing software. On *this using model I analysed the head and socket values of tension and deformation with the ANSYS software with finite-element. Without exception we examined it together first, then however it is separate the head and separately the socket. The received results come up to our expectations.*

Aknowledgement

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