NUMERICAL AND EXPERIMENTAL ANALYSIS OF THE STATE OF STRESSES OF THE FEMORAL NECK – PLANE MODELING

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1. Introduction

The femoral bone is positioned between the hip joint and the knee joint, the upper extrimity taking on the bodies weight that is transmitted by the vertebral column to the pelvis (Fig.1) [1].

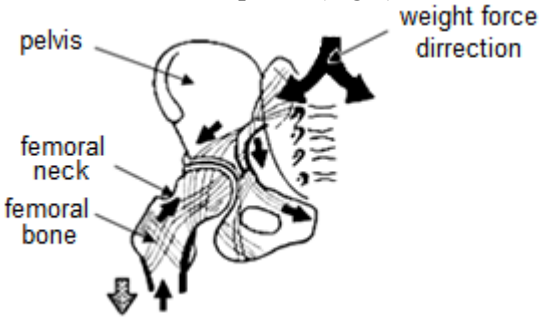


Fig. 1: Direction of the body weight to the femur [1]

The femoral bone fractures occur in the femoral neck region. The paper wants to show the state of stresses and the displacements that take place during the compression load in the femoral neck area – plane modelling.

Were approached three cases: 1) the femoral neck is not sectioned; 2) in the fractured area two screws are introduced, both having equal diameters; 3) the reconstruction is achieved with 3 screws of different diameters.

The study uses finite element method (RDM) and Digital Correlation System (DIC).

2. Numerical analysis

In Figure 2 is presented the meshing pattern (triangular finite elements), bearing and load. For the three cases reminded earlier we have made a study that highlights the equivalent stresses distribution (Fig.3).

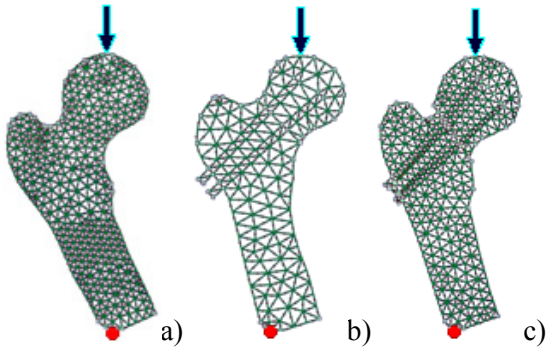


Fig.2: Plane model: a) without section b) two screws c) three screws

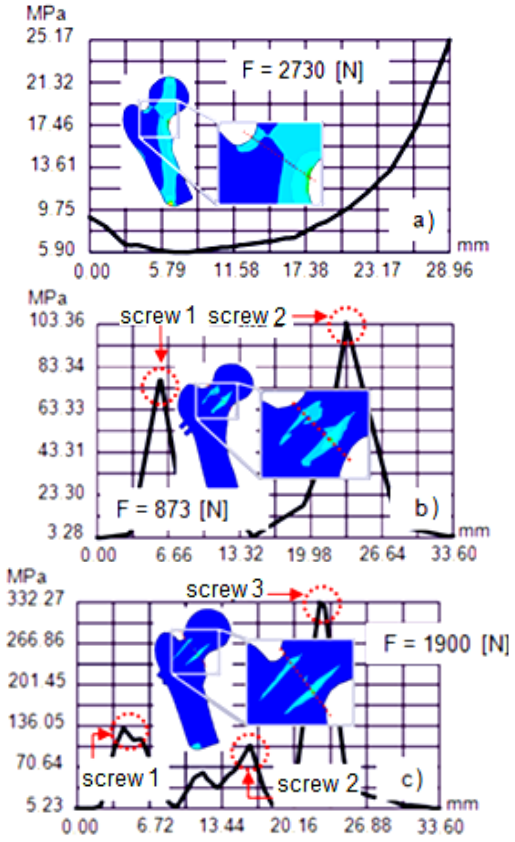


Fig.3: Tresca equivalent stresses distribution in the femoral neck section: a) model without section b) two screws c) three screws

3. Experimental analysis

For the experimental study we used DIC (Fig.4). The material chosen to make the plane

model of the upper extremity of the femoral bone is epoxy resin.

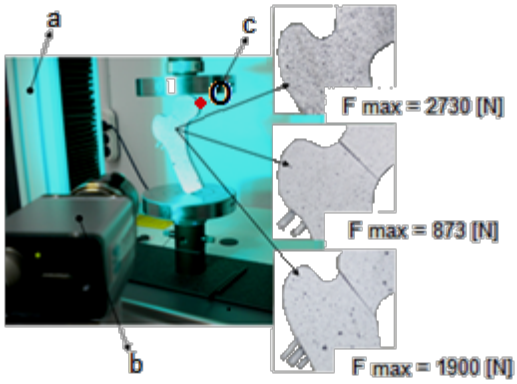
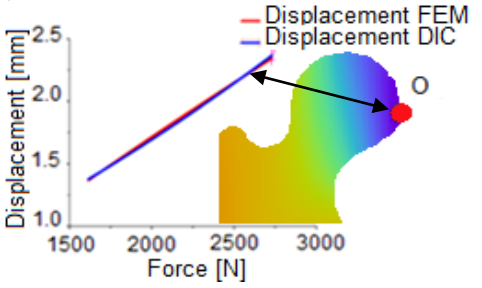
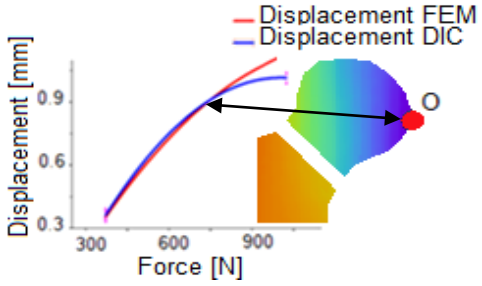


Fig.4: Experimental setup: a) Instron 3366-1tf testing machine; b) Dantec Dynamics Q-400 DIC system; c) the point where the displacement is measured

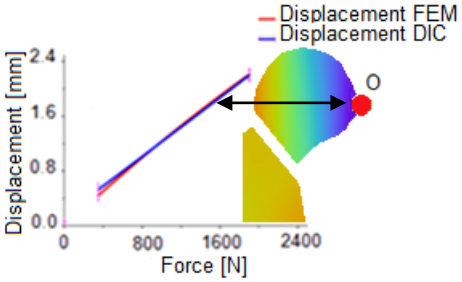
Figure 5 represents the displacement variation (RDM and DIC) of O in keeping with the force that is applied. O lies on the femoral heads outline (Fig.6).



a)



b)



c)

Fig.5: The displacement variation in vertical plane of O in keeping with the force: a) model without section b) with two screws c) with three screws

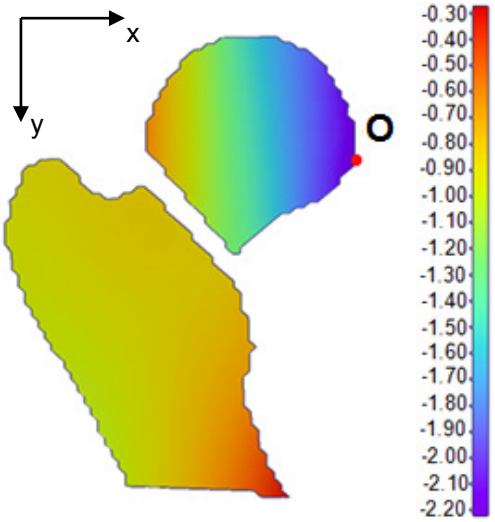


Fig.6: The displacement field in relation with the Y axes of the plane model with three screws

4. Conclusions

From the study conducted we can conclude the following:

- O's displacements in keeping with the Y axes record a linear variation and the relative errors between the numerical results (RDM) and the experimental ones (DIC) are under 6 percent.
- The numerical and experimental analysis identifies the area were the load is maximum, which is the femoral neck area.
- In the cases of the models with two and three screws the maximum stresses appear in the lower screws.

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