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Komputerowe wspomaganie zabiegu alloplastyki stawu biodrowego człowieka

Rozprawa doktorska

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SUMMARY

In the work the investigations in the area of human hip joint biomechanics were presented. In the first part of dissertation the method of creation the numerical models basing on the tomography data was shown. The following stages were particularly described:

- the data acquisition and method of processing the digital images,
- the images segmentation and establishing the anthropometric data,
- the process of creation the triangle mesh and the optimization method of its quality,
- the process of creation the surface models (NURBS surface),
- the process of creation the solid models (CAD modelling),
- the process of creation the volume mesh and the optimization method of its quality.

The above methodology was enriched by the proposed method of volumetric way of modelling the material parameters values and their heterogeneous distribution. This method allows to obtain the average value of Young modulus E in the whole examined structure assumed by investigator (i.e. basing on the experiments). The proposed approach was presented on the example of the study of influence the $E(\rho_{app})$ relation onto the strain and stress state of cubical sample of cancellous bone extracted from femoral head. The method was also tested on the sensitivity of the elements size of mesh. The way of adaptation of literature relations $E(\rho_{app})$ for the form allowing to obtain assumed average value of material parameter was shown, too. The influence of material values and distribution onto the strain and stress state in area of the femoral neck and shaft in case of the femur after cement arthroplasty was additionally discussed.

In the next part of thesis the results of FEM analyses of biomechanical systems were presented. The investigation concerned the following structures:

- the hip joint before operation (anatomically correct),
- the hip joint after the resurfacing operation of femoral head using the Birmingham approach (BHR),
- the hip joint after the total cement arthroplasty (THA).

Due to the fact of taking into account the pelvis bone for the calculation, the tasks were solved with the defined contact between the cooperating segments. In the first step, the verification of results of hip joint before operation were conducted in relation to literature. In the second step, the analyses of hips after operation relating to stage before operation were compared.

The presented methodology of creation of the numerical models enables to prepare precisely every biomechanical model Simultaneously, application of volumetric approach to model the heterogeneous material parameters distribution allows to simulate every physiological state of bone.