DEVELOMENT OF A PHYSIOGNOMIC HIP JOINT REPLACEMENT

Jan Sykora*, Svatava Konvickova, Matej Daniel

Laboratory of Human Biomechanics, CTU in Prague,
Faculty of Mechanical Engineering,
Department of Mechanics,
4 Technicka str., 166 07, Prague 6, Czech Republic
*MAILTO: J.Sykora@sh.cvut.cz

[Engineering of Biomaterials, 89-91, (2009), 17]

Introduction

Ultra high molecular weight polyethylene (UHMWPE) is the most popular material for manufacturing a hip joint cups. The Abrasion of UHMWPE is the biggest problem of a total hip joint replacement in this time. The wear debris spread to the surroundings of the total replacement and react with tissue that causes to implant loosening. There are two different ways to the reduction wear. Development of new materials and material combination is first way, second way is arrangement of the articulation surfaces geometry (slide pair hip cup – femoral head). We developed a physiognomic total hip joint replacement with arrangement geometry.

Materials and methods

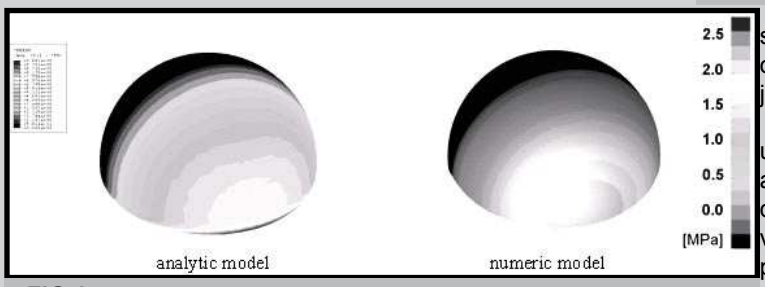

FIG.1.

FIG.2.

We indicate on the basis of the comparison our results of mathematical (analytic model) and finite element models (numeric model) of a contact stress distribution, that it is possible to use the finite element method (FEM) for the modeling of the non-weigh bearing part of the total replacement of the hip joint (FIG.1). The point of this technical solution of the new hip cup is to design such a shape of the joint surface that will be symmetrical towards the hip joint force. The shape is designed as the basic mathematical models of the distribution of the contact stress [1]. Three basic forms of this shape were designed (FIG.2). The cup with the hole was chose as the most suitable [2] (FIG.2 A).

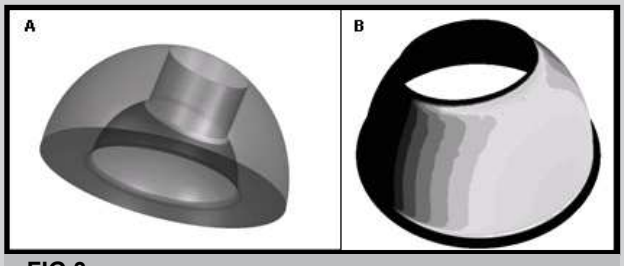

FIG.3.

The comparison of the contact stress distribution analytic model of the classic cup and cup with hollow show, that the contact stress distribution of the cup with hollow is more uniform. Decrease of the contact stress gradient by way of modification of the non-weigh bearing area was succeeded. The maximal value of the contact stress was increased by the hollow in the non-weigh bearing area. This maximum was on the edge of the hollow. We substituted this concentrator by fillet edge (FIG.3.A). We attempted to decrease maximal value of the contact stress by this modification. This attempt was successfully (FIG.3.B)

Discussion and conclusion

The manufacture of the hip cups with modification is very exacting and for that reason very expensive then femoral head with modification. Therefore we changed cup modification to femoral head modification.

We created three models of the femoral head with different modification. The shape of these heads was designed

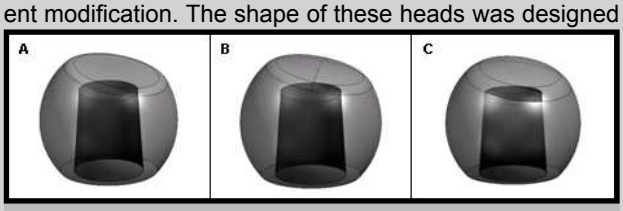

FIG.4.

symmetrical towards the hip joint force. This is point of technical solution of the physiognomic total hip joint replacement.

The computations with modified hip cups weren't useless. We demonstrated that it is possible to achieve more uniform contact stress distribution from design of the non-weigh bearing area of the hip. We verified original idea and tried some technical principles that will be use in future.

The FEM models of the modified heads are complete and we waiting for results. These results will be study and compare with previous results.

In next phase of development we will focus on determination of the contact stress distribution by experiment. Resultant contact stress distribution will be compare with FEM computations. We will choose next development way on the basis these results.

Acknowledgement

The research is supported by the Ministry of Education project: Transdisciplinary research in Biomedical Engineering II., No. MSM 6840770012.

References

[1] Daniel M., Sýkora J., Goldman T., Konvičkova S., New design of the acetabular component for total hip replacement., Biomechanics of Man, Spicak, 2004
[2] Daniel M., Sýkora J., Konvičkova S., Development of new design of the acetabular component for total hip replacement., Conference on Biomaterials in Medicine and Veterinary, Rytro, 2005