BIOMECHANICAL RESEARCH ON A NEW TYPE OF SANDWICH CUP FOR TOTAL HIP REPLACEMENT

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OBJECTIVE

At present, abrassion of implanted ultra high molecular weight polyethylene (UHMWPE) seems to be the most important factor participating in endoprosthesis loosening. Created is so-called polyethylene granulom having a toxic effect and which is a major cause of osteolysis, gradual bone degeneration and subsequent prostheses loosening. For this reason, the ceramics, Al_2O_3, was introduced to the design of the total hip replacement. As the best solution the application of the ceramics is to both parts of the prosthesis, i.e. to the head and the cup. The advantages of the frictional couple of ceramics-ceramics, concomitantly with the damping effect of the plastics, are combined in a new cup type, the so-named sandwich cup, presently now being developed in the Czech Republic.

METHOD

The new sandwich cup is designed as a polyethylene cup with a ceramic lining. The development of a new type of cup covered both the theoretical and experimental research. The contact pressure and contact surface between the head and the ceramic and sandwich cup were calculated by means of finite element method (FEM) and compared with the value of contact pressure and contact surface on the polyethylene cup. The experimental research incorporated the measurement of the frictional resistance, fatigue and impact tests . Research on the influence of different lubricants was also carried out. The frictional resistance is an important factor serving for the comparison of the hitherto applied endoprosthesis designs (being compounded of the polyethylene cup and the ceramic head) with the newly developed prosthesis type, where, as a frictional couple, there serves the combination "ceramics-ceramics". The frictional resistance in the hip joint total prosthesis was measured by means of a testing device which was developed at the Czech Technical University. This testing device allowed a swinging motion of the ceramic head in the test cup in the range of ± 25° and was mounted into a loading machine, which enabled continuous loading by axial force and its measuring. For comparison of the frictional resistance of singularly measured couples "cup-head", the energy absorbed was ascertained (which was necessary for inducing the swinging motion over the time internal of 35 sec).

RESULTS

For the experimental and theoretical research 8 ceramic cups of diameter 28.015 mm - 28.13 mm, 4 polyethylene (UHMWPE) cups of diameter 27.998 - 28.55 mm and 1 ceramic head of diameter 27.993 mm were used.

The measurement was carried out at the loading levels 0; 500; 1000; 1500 and 2000 N. In fig.1 is the dependence of contact pressure on axial force for all samples, it means for all couples ceramic head-ceramic cup, ceramic head-

polyethylene cup and ceramic head-sandwich cup. All conntact presures are in permissable limits.

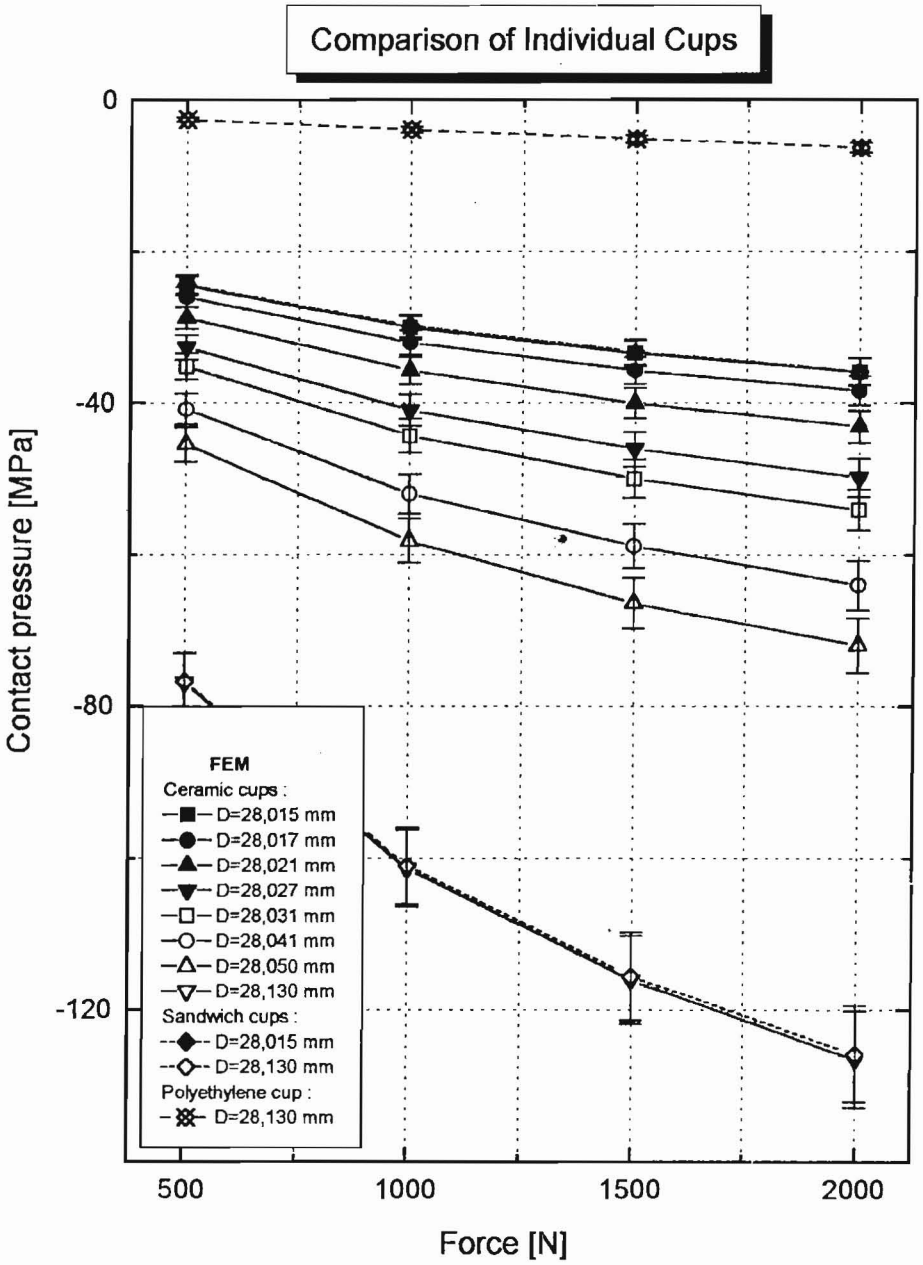

Fig. 1

From fig.2 it can be seen that the couples "ceramic head-sandwich cup with ceramic lining" have substantially lower passive resistances than the couples polyethylene cup-ceramic head.

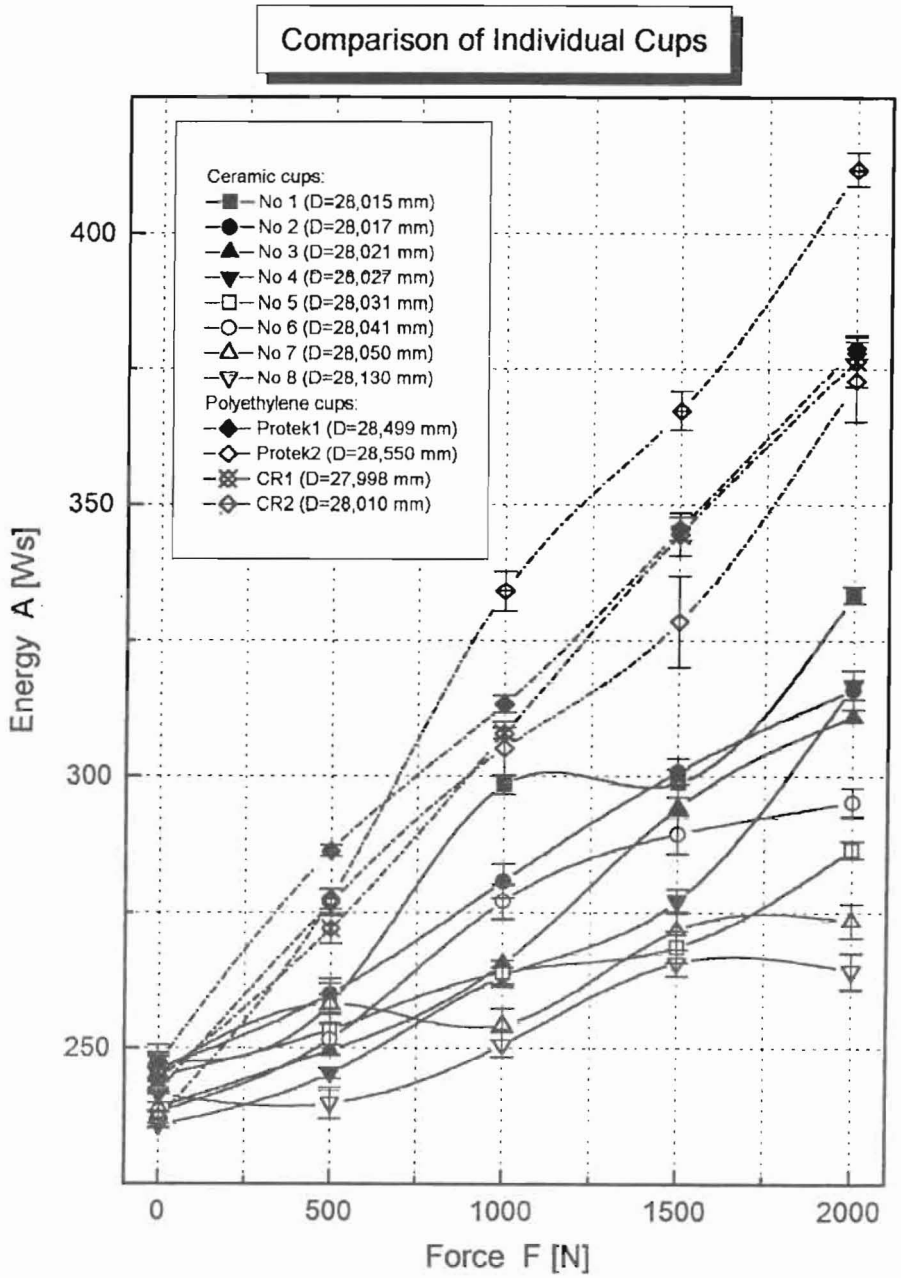

Fig. 2

CONCLUSION

The possibility of using the diameter differences of ceramic cup-ceramic head ranging from 0.022 mm to 0.137 mm (rather than the value 0.01 mm reported in literature) showed to be effective on the basis of measurement of the frictional resistance.

The new type of sandwich cup was developed, and, with very good results, used at the Orthopaedic Clinic of Charles University in Prague.

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