Determination of wear in Artificial Hip Implants

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The main objective of this work is to calculate the three dimensional cartilage contact stresses and contact pressure of UHMWPE acetabular cup and correlate them with wear in Total Hip Replacement (THR). This computational work examines the accumulated pressure exposure over a gait cycle that may cause osteolysis in the human hip. The study also examines the effect of cup geometry, abduction angles, thickness and clearance of UHMWPE, which can alter the stress in polyethylene liner.

A finite element model of THR was developed using the Ansys code and subjected to gait loads. Two additional designs were also reconstructed to test the effects of the cup clearance and thickness. Contact pressures at cup head and cup cement interfaces were calculated as a function of loading forces at 45°, 60° and 80° abduction angles. At the cup head interface, larger diameter cups experienced lower contact pressures at low loading forces. At high loading forces much higher contact pressures were produced on the surface of the cup. An increase in the abduction angle increased the contact pressure in large diameter cups. Increased clearance between cup and head increased the contact pressure both at cup head and cup-cement interfaces, whereas decreased thickness of polyethylene layer increased contact pressure only at the cup cement interface. Peak contact pressures ranged from 3-10 Mpa and cumulative contact pressures ranging from 2-6 Mpa per gait cycle were recorded. The magnitudes of peak cumulative contact pressures differed between opposite articular surfaces. FEA results showed that geometrical design, thickness and abduction angle of the acetabular cup, as well as the clearance between the cup and head do change significantly the mechanical stresses experienced by a cemented UHMWPE acetabular cup.