

Biomechanical consequences of humeral head flattening due to osteoarthritis.

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Introduction.

Arthritis of the glenohumeral joint is usually associated with erosion and flattening of the articular surfaces. The aim of this study was to evaluate the influence of the articular flattening on the joint reaction forces and the humeral head translations during abduction and rotation.

Method.

Analysis was conducted with a 3D finite element model of the shoulder, including the scapula, the humerus and 6 muscles : middle, anterior and posterior deltoid, supraspinatus, subscapularis, and infraspinatus. Both the glenoid and humeral head were eroded to artificially reproduce the flattening of an arthritic joint. Two situations were studied : 1) an intact joint with a radius of curvature of 24mm for the humeral head and 26mm for the glenoid; 2) an eroded joint with a radius of curvature of 40mm for the humeral head and 42mm for the glenoid. Movements of external rotation (0-45°) and abduction (0-150°) were performed by muscles' activation. Contact forces caused by muscles wrapping on bony surfaces were accounted for. Joints forces, glenohumeral contact point locations and humeral head translations were calculated for the intact and eroded joint.

Results.

For the eroded joint, articular forces were up to seven times higher during rotation and five times higher during abduction. For the intact joint, the glenohumeral contact point and humeral head remained centred. On the other hand, for the eroded joint, eccentric contact points with large antero-posterior and supero-inferior humeral head translations were observed. Animated views showed that this fact was clearly related to the rocking-horse effect.

Conclusions.

This study showed that flattening of the glenohumeral joint due to osteoarthritis increases dramatically the articular forces and humeral head translations. This phenomenon is by itself responsible for progression of the joint's erosion and flattening and acts as a vicious cycle. It also partly explains the reduced range of motion observed clinically. Accordingly, to limit the risks of rocking-horse effect after shoulder arthroplasty, the joint's reconstruction should restore a natural articular radius of curvature, with a centre of rotation in the middle of the humeral head.