

Anatomical shoulder prostheses : consequences of supraspinatus deficiency.

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Introduction.

Anatomical total shoulder prostheses are usually not indicated in cases of glenohumeral degenerative diseases associated with rotator cuff deficiency. Asymmetrical load of the glenoid could increase the risks of implant loosening. The aim of this study was to analyse the consequences of supraspinatus deficiency on the glenoid stresses.

Method.

Analysis was conducted with a 3-D finite element model of the shoulder, including the scapula, the humerus and 6 muscles : middle, anterior and posterior deltoid, supraspinatus, subscapularis, and infraspinatus. An anatomical shoulder prosthesis (Aequalis, Tornier) was numerically implanted. Movements of abduction (0-150°) were performed by muscles' activation. Scapulo-thoracic rhythm was taken into account. Contact forces caused by muscles wrapping on bony surfaces were also accounted for. Two situations were studied : 1) with an intact rotator cuff; 2) without any supraspinatus muscle. Glenohumeral forces and pressures were calculated for the two situations. Stresses within the cement, at the bone-cement interface and in the glenoid bone were also analysed. Animated views allowed to evaluate the glenohumeral contact point and humeral head translations.

Results.

The absence of supraspinatus muscle had many consequences : it increased significantly the superior translation of the humeral head during abduction, which occurred earlier at the beginning of movement; it did not modify the articular force and pressure, but maximum values were obtained at smaller angles of abduction (75° against 90°); the strength of deltoid necessary for abduction was increased of 55%. The supraspinatus insufficiency also increased stresses of about 28% within the cement, 18% at the bone-cement interface and 6% within the glenoid bone.

Conclusions.

Animated views demonstrated clearly the occurrence of a rocking-horse phenomenon when an anatomical shoulder prosthesis is implanted without a functional supraspinatus. The asymmetrical load of the glenoid induced deleterious biomechanical effects. This situation may lead to cement and/or cement-bone interface failure, and could preclude the long term survival of the prosthetic implant.