

Shoulder reversed prostheses : three-dimensional evaluation of impingements.

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Introduction.

The medial displacement of the glenohumeral centre of rotation is a main characteristic of the reversed shoulder prostheses. It increases the deltoid lever arm, what is an advantage for the abduction. However it also induces mechanical impingements between bone and implants. The aim of the study was to develop a 3D map of impingements and to analyse the consequences of the inferior positioning of the base plate.

Method.

A 3D numerical model of the shoulder (humerus, scapula, clavicle) was created with data obtained from CT scan. A reversed shoulder prosthesis (Reversed Aequalis, Tornier) was numerically implanted. The model allowed a 3D mobility and all the possible movements were tested. The angles of impingements were measured and 3D maps were draught. 3D animations allowed to see precisely the location of the impingements and the structures involved. Two positions of the glenoid base plate (centred and inferior) were evaluated.

Results.

Adduction (isolated or combined with flexion/extension) induced impingements between the inferior (+/- anterior or posterior) glenoid and the humeral prosthesis. Flexion provoked impingements with the coracoid process. Abduction created impingements between the greater tuberosity and the acromion or the spine of the scapula. Internal rotation (15°) decreased the impingements in flexion, without modifying the risks in abduction/adduction. The inferior positioning of the base plate allowed to decrease the impingements in adduction (0° against 30°), in abduction (92° against 70°), but did not modify the flexion (115°). However, it tripled the volume of space reachable by the arm.

Conclusions.

The medial displacement of the centre of rotation with reversed shoulder prostheses provokes impingements, not only with the inferior part of the glenoid, but also with the anterior and posterior glenoid, the coracoid, the acromion and the spine of the scapula. This fact could explain the increasing number of fractures of the acromion recently reported in the literature. Impingements are a 3D problem and numerical modelling may help in the development of new prosthetic designs .