INTRODUCTION: For patients with endstage shoulder disease that includes irreparable rotator cuff tendon tears, traditional shoulder replacement does not offer significant improvements in function. Reverse total shoulder replacements, on the other hand, can allow improvements in both pain relief and function for these patients by changing the biomechanics of the shoulder. Our objective was to analyze the forces across the reverse total shoulder glenoid component, specifically shear forces and moments that could affect initial implant fixation. Joint forces were measured during simulated active elevation in cadaveric shoulders for two different reverse total shoulder implantation systems with different glenoid component designs.

METHODS: The DePuy Delta III and the Encore RSP prostheses were each implanted in one shoulder of a matched pair according to the guidelines provided by the manufacturers. During the surgery all muscles were released with the exception of the subscapularis and teres minor, and a fabric strap was sutured to the deltoid tendon insertion. The other end of the strap was attached to a motor which applied the deltoid force. The total weight of the humerus and its fixtures simulated 25% of the maximum moment experienced by an average arm. The shoulder was mounted to a custom mechanical rig where stepper motors were used to move the scapula and humerus independently (Figure 2). Software was written to dynamically control the motion of the shoulder such that there was a constant 2:1 glenohumeral-scapulothoracic rotation ratio. The angles of rotation of both the scapula and humerus were dynamically recorded, as was the force applied to the deltoid.

RESULTS: Calculated joint forces (given in percent body weight (BW)) (Figure 3) for the Encore RSP implant were slightly higher than the DePuy Delta III, although both implant resultant joint forces were lower than those forces across a normal shoulder elevated in the plane of the scapula [1]. Greater forces are apparent in the plane rotated 35 degrees internally than those in the plane of the scapula. Shear forces are comparable between the two implant systems in the plane of the scapula, whereas the DePuy Delta III [2] has a higher shear force when the humerus is internally rotated (Figure 4). There is a noticeable consistent difference in the angle of the deltoid (Figure 5) throughout arm elevation, with the Encore RSP producing a greater deltoid angle than the DePuy Delta III systems.

DISCUSSION: The main difference between the Encore RSP and the DePuy Delta III implant systems is the glenoid component design, with a larger offset away from the native glenoid in the Encore RSP [2] prostheses (Figure 1). We observed that the larger offset minimized the amount of component impingement against the bone at small angles of arm elevation. Another result of the larger offset was that the deltoid angle was consistently larger for the Encore RSP system (Figure 5) leading to higher overall forces across the joint (Figure 3). The shear forces however did not seem to drastically differ between the two implant systems in the plane of the scapula (Figure 4), although a greater moment produced by a larger implant offset could disturb the initial implant-bone fixation.


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