INTRODUCTION

Reverse total shoulder arthroplasty (RTSA) increasingly is utilized to restore shoulder function in patients with osteoarthritis and rotator cuff deficiency. However, little is known about post-RTSA shoulder function. We assume that better knowledge of how RTSA affects shoulder function and muscle activation patterns will lead to refinement in the design, utilization and rehabilitation strategies for RTSA. Deltoid muscle activity in the rotator cuff deficient shoulder is of particular interest to determine how patients compensate for lost rotator cuff function with restored glenohumeral stability. The purpose of this study was to evaluate deltoid and upper-trapezius muscle activity between the involved and non-involved side of medial RTSA patients during active shoulder weighted and unweighted abduction, weighted and unweighted flexion and external rotation. Motion capture and electromyography (EMG) were used to quantify 3D motion and muscle activation.

METHODS

Fifty subjects participated in this IRB approved study. Subjects who were at least 6 months post RTSA comprised the experimental group. All subjects performed three arm motions in unweighted and weighted (3 lb) conditions: abduction to the side, forward flexion in the sagittal plane and external rotation with the arm at the side. EMG activation of the anterior (AD), Lateral (LD) and posterior (PD) aspects of the deltoid and upper trapezius (UT) muscles were recorded using bipolar surface electrodes (Noraxon USA inc. Scottsdale, AZ). Motion capture using passive reflective markers was used to quantify 3D shoulder motions. Maximal voluntary isometric contractions (MVIC) were used to normalize activity for each muscle. Two-way repeated-measures ANOVA is used to compare groups. Tukey’s Honestly Significant Difference was used to perform pair-wise post-hoc comparisons. The level of significance for ANOVA was chosen to be 0.05.

RESULTS AND DISCUSSION

Muscle activation of the lateral deltoit and the upper trapezius was significantly higher in the involved shoulder than non-involved shoulder during abduction (Fig. 1; LD: p=1E-09). This trend is also seen in both weighted and unweighted trials of flexion in the lateral deltoid (Figs. 2&3; AD: p=0.000601). Posterior deltoid activity in all activities averaged less than 20% of MVIC. Maximum posterior deltoid activity of 18% MVIC was observed during external rotation, when the reaction force at the wrist averaged 25N.

The goal of this study was to contrast muscle activation in involved and noninvolved sides of patients with unilateral RTSA during unweighted and weighted activities.

Figure 1: Lateral deltoit activation was greater in involved side RTSA shoulder than the non-involved side during unweighted and weighted abduction.
CONCLUSIONS

Our data suggest RTSA simplifies deltoid muscle activation. We observed high muscle activation in the portion of the deltoid directly in line with the task, but reduced muscle function in the out-of-line portions of the muscle. It appears the intrinsic stability provided by the RTSA allows the out-of-line portions of the muscle to be relatively relaxed, whereas those portions of the muscle in the unininvolved shoulder appear to be actively stabilizing the joint. This is shown in figures 1, 2, and 3 where the muscle activity is significantly greater in the involved side for conditions in which the activated muscle lies along the plane of motion. This is even more pronounced in weighted trials. It was also found that the posterior deltoid was minimally active in all the activities tested. These observations of muscle function in RTSA shoulders improve our understanding of joint function and will inform efforts to improve RTSA implant design, surgical technique and rehabilitation.