9-2014

How Sensitive is the Deltoid Moment Arm to Joint Center Changes with RTSA?

David Walker
University of Florida

Allison Kinney
University of Dayton, akinney2@udayton.edu

Aimee Struk
University of Florida

Benjamin J. Fregly
University of Florida

Thomas Wright
University of Florida

See next page for additional authors

Author(s)
David Walker, Allison Kinney, Aimee Struk, Benjamin J. Fregly, Thomas Wright, and Scott Banks

Poster: #3167

How Sensitive Is the Deltoid Moment Arm to Joint Center Changes With RTSA?

*David Walker - University of Florida - Gainvesille, USA
Allison Kinney - University of Florida - gainesville, USA
Aimee Struk - University of Florida - Gainesville, USA
B.J. Fregly
Thomas Wright - UFL - USA
Scott Banks - University of Florida - Gainesville, USA

*Email: drew208@ufl.edu

Reverse total shoulder arthroplasty (RTSA) is an increasingly common treatment for osteoarthritic shoulders with irreparable rotator cuff tears. Although very successful in alleviating pain and restoring some function there is little objective information relating geometric changes imposed by the reverse shoulder and the moment generating capacity of the shoulder muscles. Recent modeling studies of reverse shoulders have shown significant variation in deltoid muscle moment arms over varied joint centers for shoulders with RTSA. The goal of this study was to investigate the sensitivity of muscle moment arms as a function of varying the joint center in one representative RTSA subject. We hypothesized there may exist a more beneficial joint implant placement, measured by muscle moment arms, compared to the actual surgical implant placement.

A 12 degree of freedom, subject-specific model was used to represent the shoulder of a patient with RTSA for whom fluoroscopic measurements of scapular and humeral kinematics during abduction had been obtained. The computer model used these abduction kinematics and systematically varied joint center locations over 1521 different perturbations from the surgical placement to determine moment arms for the anterior, lateral and posterior aspects of the deltoid muscle. The joint center was varied from its surgical position ±4 mm in the anterior/posterior direction, 0-24 mm in the medial/lateral direction, and -10 mm to 14 mm in the superior/inferior direction.

The anterior deltoid moment arm varied up to 16mm with center of rotations variations, primarily in the medial/lateral and superior/inferior directions (Figure 2, Table 1(Figure 1)). Similarly, the lateral deltoid moment arm demonstrated variations up to 13 mm, primarily with joint center changes in the anterior/posterior and superior/inferior directions. The posterior deltoid moment arm varied up to 10mm, primarily in early abduction, and was most sensitive to changes of the joint center in demonstrated a sensitivity of 6 mm corresponding to variations in the superior/inferior directions (Figure 2).

The goal of this study was to assess the sensitivity of the deltoid muscle moment arms as a function of joint configuration for an existing RTSA subject. High variations were found for all three deltoid components. Variation over the entire abduction arc was greatest in the anterior and lateral deltoid, while the posterior deltoid moment arm was mostly sensitive to joint center changes early in the abduction arc. Moment arm changes of 10-16mm represent a significant amount of the total deltoid moment arm. This means there is an opportunity to dramatically change the deltoid moments arms through surgical placement of the joint center of rotation. Computational models of the shoulder may help surgeons optimize subject-specific placement of RTSA implants to provide the best possible muscle function, and assist implant designers to configure devices for the best overall performance.

Figures

Table 1. Peak sensitivity of muscle moment arms to joint center variation

Muscle	Anterior/Posterior (mm)	Medial/Lateral (mm)	Superior/Inferior (mm)
Anterior Deltoid	1.5 @7°	11.0 @17°	3.3 @21°
Lateral Deltoid	4.3 @31°	1.5 @33°	7.2 @31°
Posterior Deltoid	3.0@7°	1.0 @37°	6.0 @7°

Figure 1

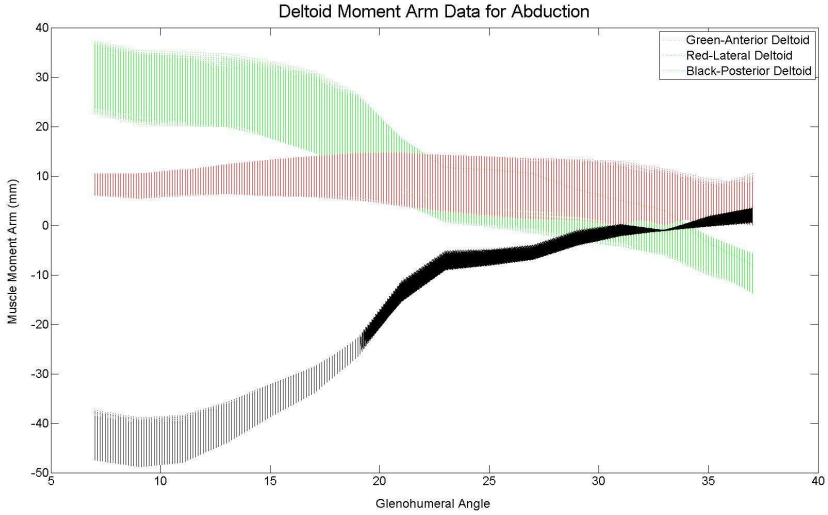

Figure 2