INTRODUCTION:
Reverse Total Shoulder Arthroplasty (RTSA) offers pain relief and functional improvement for patients with fracture sequelae and an incompetent rotator cuff (1, 2, 3). Recently, modular stems have allowed conversion of hemiarthroplasties to RTSA. However, there is concern that hemiarthroplasties are implanted with too much retroversion, around 30-40 degrees, to accommodate a RTSA, which is routinely placed in 0-20 degrees of retroversion (4). It is unclear what the ramifications of placing a RTSA in up to 30-40 degrees of retroversion is, though recent studies have suggested that it may lead to instability from impingement and muscle imbalance (4). This study aims to determine the effect of humeral retroversion on the scaption ability (elevation in the plane of the scapula) following RTSA. Our hypothesis was that there would be no differences in the muscle forces across the shoulder between various humeral retroversions.

METHODS:
Six cadavers were dissected except for tendon attachments to subscapularis (SSC), teres minor (TM), lattissimus dorsi (LD), pectoralis major (PM), and the anterior (AD), middle (MD) and posterior (PD) deltoïds. A RTSA (Biomet Comprehensive Reverse, Warsaw, IN) was implanted in 0, 20, 30 and 40 degrees of retroversion relative to the forearm using the alignment guide provided in the instrumentation set. Once the various degrees of retroversion were marked on the specimen, the humerus was sectioned just above the epicondyles. A rod and 3.5kg weight were placed 315mm from the top of the greater tuberosity to mimic the center of gravity for the entire upper extremity (5). Shoulders were mounted on a custom simulator, which included stepper motors attached to the tendons, a tracking system (Qualisys), and a control system developed in Matlab. Shoulder motion was performed via the motors using an optimization-based physiologic criterion. The algorithm was created in our laboratory and factors the line of action of each muscle force as well as their relative force contribution based on their average cross-sectional area (6). The optimal solution is the one that distributed the least stress across the joint. For each retroversion, the average force for each muscle required to achieve 30 degrees of scaption was recorded and compared using a two-way ANOVA.

RESULTS:
The average force required for 30 degrees of scaption across all retroversions was: SSC 4.6±4.2N, AD 30.0±5.4N, MD 70.5±13.0N, PD 22.3±5.6N. There were no differences in the force required of each muscle to achieve 30 degrees of scaption at any humeral retroversion.

DISCUSSION:
Retroversion did not significantly affect the scaption ability of the RTSA in this model. Furthermore, there were no significant changes in the force across each muscle for different humeral retroversions. This supports the idea of modularly converting a retroverted hemiarthroplasty stem into a reverse prosthesis in the setting of tuberosity malunion, nonunion, or dissolution. However, further studies are needed to determine the arc of motion and stability each retroversion affords in order to determine the clinical consequences of placing a RTSA in varying degrees of retroversion.

REFERENCES:
1. Wall et al. JBJS-Am, 2007
2. Levy et al. JBJS-Am, 2007
4. Favre et al. JSES, 2010

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