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An Analysis of Glenohumeral Elevation Using 3D Computed Tomography (3D Ct) in Patients with Shoulder Instability

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Summary:
Surgical intervention for shoulder instability limits the amount of elevation at the glenohumeral junction and may indicate the need to limit the surgical correction of shoulder instability and restore/maintain normal glenohumeral anatomy.

Abstract:
Introduction:
The shoulder joint is the most dislocated joint in the body. The incidence of dislocation in the overall population is 4%, with higher rates in athletic and military populations. Recurrent instability is a particular problem in the shoulder as recurrence rates have been reported beween 20-90%. The pathologic anatomy underlying recurrent shoulder instability includes bony abnormalities of the glenoid and humeral head, impairments and imbalances in muscle function, and ligament tears and laxity. Patients that have been diagnosed with and/or treated for shoulder instability may experience a decrease in their biomechanical range of motion, including limited amounts of elevation (abduction) at the glenohumeral junction. Normal glenohumeral elevation has a maximum of 100-110 degrees, with scapulothoracic elevation being utilized to attain greater levels of abduction. We hypothesize that patients that have experienced shoulder instability will be significantly limited in their maximal levels of glenohumeral elevation compared to normal shoulders.

Methods:
39 patients that have experienced shoulder instability were examined in the orthopedic surgery clinic at the University of Michigan. 14 of the 39 patients had failed soft tissue surgical repairs, 10 had successful surgical repairs, and 15 had no previous surgical intervention. All 39 patients had bilateral shoulder CT scans performed in three positions. These positions include 0 degrees of abduction and 0 degrees of external rotation (0-0), 30 degrees of abduction and 30 degrees of external rotation (30-30), and an overhead position at approximately 165 degrees of abduction and 55 degrees of external rotation (OH). Using MIMICS and 3-MATIC, 3D CT reconstruction is performed for both shoulders in all three positions, yielding six total models. A specialized coordinate system is used to mark specific points and directions on the humerus and glenoid of each model. These coordinates are then used to calculate the glenohumeral elevation for the normal and affected sides in the 0-0, 30-30, and OH positions.
A paired, 2-tailed t-test was used to determine any significant differences between the affected shoulder and normal, unaffected shoulder of a patient.

Results:
No differences in glenohumeral elevation were seen in the 0-0 and 30-30 positions when comparing a patient's affected shoulder to his/her normal side for all three patient groups. In the overhead position, equal amounts of abduction and external rotation were measured bilaterally using the goniometer at the time of CT acquisition for all patients. However, patients with failed surgical intervention had significantly less glenohumeral elevation on the affected side (95.6 degrees) when compared to the normal shoulder (101.5 degrees, p= .029). Surgically stabilized

shoulders (93.6 degrees) also had significantly less glenohumeral elevation compared to their normal sides (102.1 degrees, p=.035). However, unstable shoulders with no prior surgical correction (102.1 degrees) did not differ when compared to their contralateral, unaffected sides (101.9 degrees, p=.95).

Discussion:
Surgical intervention, regardless of whether it was successful or failed, limits the amount of elevation (abduction) at the glenohumeral junction. As a result, patients that have received surgical intervention may utilize greater levels of scapulothoracic elevation to attain levels of abduction equal to their normal side. This limitation in their biomechanical range of motion indicates that failed and surgically stabilized shoulders will not return completely back to normal, which may be of great importance to highly active and military populations. Conversely, patients without previous surgical correction do not have any limitations in their glenohumeral elevation
The findings regarding surgically stabilized patients corroborate the idea that a surgeon often sacrifices range of motion at the shoulder joint for stability when correcting a case of shoulder instability. Many surgeons will tighten the capsule more than normal and will limit the range of motion to ensure that the humeral head will not incur future dislocation.
The findings regarding the failed surgical intervention patients call into question the mentality that failed soft tissue repairs do not impair the function and range of motion at the shoulder joint. Each of our failed patients had a previous soft tissue repair, which significantly decreased their glenohumeral elevation in the overhead position. This indicates that there are significant lasting effects of failed soft tissue repair, suggesting that we must proceed with caution when determining the most appropriate treatment for shoulder instability. These findings also suggest that we should attempt to maintain/restore normal glenohumeral anatomy and implement other forms of treatment such as physical therapy prior to the utilization of surgical correction.
In light of these findings, we plan to enroll patients that have received physical therapy for shoulder instability to compare the biomechanical changes associated with its use to that of surgical intervention. The main limitation of this study is a small sample size. However, we will continue to add patients to strengthen our current conclusions and reveal other minor biomechanical changes.