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# Do subscapularis tears really result in superior humeral migration?

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ABSTRACT

*Objectives:* The aim of this study was to analyse the effect of subscapularis tear on superior humeral excursion (SHE) and acromiohumeral distance (AHD). The hypothesis was that subscapularis tears do not result in superior humeral excursion.
*Methods:* Patients who underwent shoulder arthroscopy between August of 2011 and 2015 were reevaluated. Those with isolated Bankart lesion were used as control group and included in the Group 1, isolated full-thickness supraspinatus tear in the Group 2, isolated subscapularis tear in the Group 3, and combined subscapularis and supraspinatus tear in the Group 4. The mean SHE and AHD measurements on magnetic resonance imaging of these groups were compared to reveal any difference in superior humeral migration (SHM).
*Results:* There were 30 patients in each group. The mean age of Group 1 (26.44 ± 8.34) was younger than the other 3 groups. The mean AHD and SHE were higher in Group 1 and 3 (Mean AHD: 12.89 ± 2.24 and 12.28 ± 1.9, respectively. Mean SHE: −3.2 ± 0.99 and −2.78 ± 0.64, respectively) than Group 2 and 4 (Mean AHD: 6.2 ± 1.78 and 6.16 ± 1.52, respectively. Mean SHE: 0.72 ± 0.65 and 1.24 ± 0.63, respectively). The AHD and SHE were strongly correlated with each other (Pearson correlation coefficient = 0.184). The inter-observer and intra-observer correlation of the measurements of SHE on MRI were excellent with intraclass correlation coefficient of 0.95 and 0.94, respectively.
*Conclusion:* Subscapularis tears do not lead to SHM and subacromial impingement. However, superior rotator cuff tears can still lead to SHM and subacromial impingement even when subscapularis tendon is intact. Level of evidence: Level III, diagnostic study
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## Introduction

The superior migration of the humeral head following rotator cuff tear was first described by Golding in 1962 and emphasised by Weiner and Macnab in 1972.[1,2] They pronounced the correlation of humeral migration and acromiohumeral narrowing secondary to rotator cuff tears. The function of rotator cuff during the scaption is thought to be stabilization of the shoulder by compressing the humeral head into the glenoid cavity, thus providing concentric rotational motion of the joint and preventing the superior migration of the humeral head.[3–5] However, the individual contribution of the rotator cuff components has no consensus among the authors investigating the superior excursion of the humeral head. There are various opinions and findings in the literature, and the vast majority of the studies support the opinion that the subscapularis and superior rotator cuff, especially the infraspinatus, have functions in superior-inferior stability of the glenohumeral joint.[6–8]

In this study, the authors sought to understand the effect of subscapularis tear on superior humeral migration and

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acromiohumeral distance. The hypothesis of the study was that subscapularis tears do not result in substantial superior humeral excursion when measured on magnetic resonance imaging (MRI) sections.

## Materials and methods

The shoulder arthroscopy database of the institute was retrieved to reevaluate surgery videos and MRI files of patients who underwent shoulder arthroscopy between August of 2011 and 2015. Only the patients with MRI findings congruent with arthroscopic findings were selected for the study, and those operated after a month later than the time of MRI procedure were not included to prevent misinterpretation. Patients with isolated Bankart lesion were used as control group and included in the Group 1, those with isolated full-thickness supraspinatus tear in the Group 2, those with isolated subscapularis tear in the Group 3, and those with both subscapularis and supraspinatus tears in the Group 4. In a previous study, the response within each subject group was normally distributed with the standard deviation of 1.3 and the difference between experimental and control means of 0.95. It is needed to study 29 experimental subjects and 29 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) of 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. The groups were arranged with 30 patients in each which enabled to use parametric tests in statistical analyses. When evaluated whether distributed normally and homogenously, AHD and SHE were appropriate as continuous variables to analyse with parametric tests. The patients constituting the groups were chosen randomly by the help of an online software named *Research Randomizer Version 4.0* (2015, by Geoffrey C. Urbaniak and Scott Plous). The mean age, gender, and the involved shoulder of the patients were recorded.

Patients with a history of prior surgery or symptoms started acutely right after a trauma in the vicinity of involved shoulders (including fractures, dislocations, and falling down); patients with osteoarthritis, inflammatory joint disease, haemophilic arthritis, and pyrophosphate disease were not included in this study. There was no patient with biceps tendon dislocation or rupture in Group 1, but when there is in other groups, those patients were excluded from the study because of causing additional superior-inferior instability in the shoulder. Superior labrum anterior posterior (SLAP) lesions were not excluded from the study, except the Group 1, because of accompanying almost always to subscapularis tears. The superior cuff tears including infraspinatus and subscapularis tears classified as Type 1 according to the Lafosse classification were also excluded.[9] The institutional review board approval was provided for this retrospective investigation.

### *Arthroscopic procedure*

All of the procedures and the classification of the subscapularis tears were performed by the senior surgeon, who had 15 years of experience in shoulder arthroscopy, and two assistants at the same institute under general anaesthesia with or without inter-scalene block or a single inter-scalene block. The operations were performed in semi-lateral position in which patients were allowed to rotate 20–30° posteriorly, thus placing the glenoid fossa parallel to the floor. The arm was in 45-degree abduction and 15-degree forward flexion under 10 lb longitudinal traction. Following the sterilisation with iodine solution and sterile draping, the standard posterior portal was constituted for the initial examination of intraarticular pathologies through a 30° rigid arthroscope. Additional portals were constituted according to the required interventions decided following the examination of shoulders by an arthroscopic probe through the anterior portal.

### *MRI procedure and the measurements on MRI*

MRI examinations were performed with a dedicated shoulder coil on a 1.5 T system (Signa, HiSpeed, General Electric Medical Systems, Milwaukee, Wisconsin) in the supine position of patients as the arm lying beside the body in neutral rotation. The imaging protocol included oblique coronal T1-weighted (TR/TE:600/16) and fat-suppressed intermediate (T2-weighted) (TR/TE:3000/56), oblique coronal T1-weighted [TR/TE:500/16] and fat-suppressed intermediate (TR/TE:3000/56), and T2-weighted axial (TR/TE:500/15, flip angle:30) images. The field of view was 18 cm, the matrix was 192–384 × 256, and slice thickness/inter-slice gap was 3–4/0–1 mm in all sequences.

A focal discontinuity in the supraspinatus tendon extending from the articular to the bursal surface was assumed to be a full thickness rotator cuff tear on coronal oblique images and appears as fluid signal intensity on T2W.[10] An increased intermediate or fluid-like signal within the substance of the tendon, tendon margin irregularity, defect within the tendon, and/or retraction of the tendon were the criteria of subscapularis tear.[11] The involvement of the signal change within the substance of the tendon determined the size of the tear as full-thickness (tear extending from the articular surface to the bursal surface) or partial tear (only a portion of the tendon).

MRI scanning evaluation and measurements were made by two authors of this study, but not the senior surgeon who performed the procedures, according to the guidance of a radiologist with the degree of Professor and dedicated to musculoskeletal imaging. These two independent observers were blinded to the clinical and arthroscopic data of the patients. One of those measured the SHE once more a month after the first measurement and was blinded to his first measurement results. The inter-observer and intra-observer correlation of the measurements of the SHE were calculated. The SHE measurements were adapted for MRI from a previous description on radiographs.[12,13] In this method, a circle tangential to the borders of the humeral head was drawn, and the center of the humeral head (COHH) was determined by the tools of the DICOM (digital imaging and communications in medicine) viewer on T1-weighted coronal oblique sections of MRI. Then, glenoid fossa was determined by the line drawn between the superior and inferior most edges of the glenoid, and then the center of the glenoid fossa (COGF) was marked on this line. A second line was drawn from the COHH perpendicular to the glenoid fossa line, and the intersection point was marked. The distance between the intersection point and the COGF was recorded as the SHE (Fig. 1). If the COGF was inferior to the intersection point, the SHE was recorded as a negative value, and if it was superior, then the SHE took a positive value.

The acromiohumeral distance (AHD) was measured on T1-weighted coronal oblique sections. The narrowest distance found on those sections between the superior aspect of the humeral head and the inferior aspect of the acromion was recorded as AHD (Fig. 2).[14]

### *Statistical analysis*

The groups were compared to each other with the Independent Samples T-Test and Kruskal–Wallis tests to assess the SHE, AHD, and age in the groups. The dichotomous variables were assessed by Crosstabs and Pearson's Chi-square test. The correlation of AHD and SHE was assessed with Pearson correlation coefficient. The reliability tests were evaluated with the Cronbach's alpha coefficient. The statistical significance was set at $P < .05$ level (2-tailed).

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