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Original Article

The Effect of Acromiohumeral Distance on Isolated Supraspinatus Tendon Tear Repair

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ABSTRACT

Objective: The aim of this study is to evaluate whether preoperative acromiohumeral distance has any prognostic value in predicting postoperative functional outcomes after repair of isolated supraspinatus tear.

Methods: Patients who underwent arthroscopic supraspinatus tear repair between 2015 and 2019 were evaluated retrospectively. Magnetic resonance imaging (MRI) and arthroscopic findings of tears were classified according to Patte classification; patients in group II, segment III in the sagittal plane, levels 1 and 2 in the frontal plane, biceps tendon intact, and without acromioplasty were included in this study. Group I consisted of 63 patients (F = 38; M = 25) with the tear at the insertion level and group II with 41 patients (F = 23; M = 18) with the stump at the level of the caput humeri. Preoperative and postoperative radiographs and MRI were compared by measuring the acromiohumeral distances of the patients. Patients were evaluated functionally with the use of American Shoulder and elbow surgeon shoulder score and Constant-Murley score.

Results: There was no significant difference between the two groups in terms of age, gender, and the affected side. Jobe and drop sign test results were significantly positive in group II. There was no significant difference between the two groups in terms of functional scores, preoperatively and postoperatively. There was a statistically significant improvement in group I in postoperative abduction, flexion, and external rotation movements in terms of joint range of motion. In radiological evaluation, there was a statistically significant difference in all measurements in group I compared to group II.

Conclusion: The preoperative acromiohumeral distance has no prognostic value in predicting postoperative functional outcomes.

Keywords: Acromiohumeral distance, arthroscopic repair, shoulder, supraspinatus tear

INTRODUCTION

The rotator cuff (RC) muscles protect the glenohumeral joint by providing the axial compressive force required for the contact of the humeral head with the glenoid joint face.[1] In RC tears, with the disappearance of compressive force, the deltoid muscle becomes the main force that pulls the humeral head upwards.[2] Golding,[3] in their study of 150 asymptomatic people, suggested that acromiohumeral distance (AHD) may vary between 6 and 14 mm. It has been stated that AHD smaller than 6-7 mm is associated with RC tears, and values below 6 mm are a reliable radiological finding of massive RC tears that cannot be successfully repaired.[2–5]

Hamada et al.[6] were the first author to describe the progression of radiological findings of massive RC tears. In RC rupture, it has been stated that the deltoid muscle contracts with the flexion movement and the humeral head migrates proximally, thus causing a decrease in AHD. In the advanced stage, they suggested that the force transferred to the long head of the biceps by suppressing the humeral head down increased, and the mechanical friction seen between the humeral head and the lower surface of the acromion could tear the long head of the biceps tendon and narrow the AHD further.[6] This explains the more frequent rupture of the supraspinatus tendon.[7]

There are studies in the literature on the effect of posterior and posterosuperior localized infraspinatus tendon ruptures on AHD.[8–11] There are debates on the importance of isolated supraspinatus rupture in AHD. With this study, we aim to evaluate whether preoperative AHD has any prognostic value in predicting postoperative functional outcomes after repair of isolated supraspinatus tears.

METHODS

This study was prospectively registered to ethical board of The Gaziosmanpasa University Medical Faculty approval and grant number of the study is 20-KAEK-278. In our study, patients who underwent arthroscopic supraspinatus tendon tear repair between 2015 and 2019 were evaluated retrospectively. Exclusion criteria: <35 and >75 years of age, follow-up for less than 12 months, history of rheumatologic and neurological diseases, the previous shoulder joint infection, fracture or surgery in the shoulder area, pseudoparalysis, acromion pathology, and biceps pathology with grade 3 or higher glenohumeral

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Table 1. Patte Classication

Extend of tear	Group I: partial tears and full-thickness tears <1 cm in sagittal diameter;
	A: deep partial tears
	B: supercial tears
	C: small full substance tear
	Group II: full substance tears of entire supraspinatus
	Group III: full substance tears involving more than one tendon
	Group IV: massive tears with secondary osteoarthritis
Topography of tear in sagittal plane	Segment 1: subscapularis tear
	Segment 2: coracohumeral ligament tear
	Segment 3: isolated supraspinatus tear
	Segment 4: entire supraspinatus and half of infraspinatus tear
	Segment 5: entire supraspinatus and infraspinatus tear
	Segment 6: subscapularis, supraspinatus and infraspinatus tear
Topography of tear in frontal plane	Stage 1: proximal stump close to bony insertion
	Stage 2: proximal stump at level of humeral head
	Stage 3: proximal stump at level of glenoid
Quality of muscle	1. Minimal fatty layer
	2. Fatty tissue less than muscle tissue
	3. Fatty tissue is equal to muscle tissue
	4. Fatty tissue more than muscle tissue
State of long head of biceps	1. Intact
	2. Subluxation
	3. Dislocation

arthrosis according to Hamada classification.[6,12] Magnetic resonance imaging (MRI) and arthroscopic findings of tears were classified according to Patte classification[13] (Table 1). Patients with the degree of a tear in group II, segment III in the sagittal plane, levels 1 and 2 in the frontal plane, intact biceps tendon, and without acromioplasty have been filtered from records and surgery notes. One hundred and fifty-eight patients meeting the current criteria were identified, and 104 patients who came for the last control were included in this study.

Main Points

- It was determined that as the degree of supraspinatus tear increased, preoperative physical examination findings and symptoms were more severe, but preoperative functional life scores did not differ.
- Postoperatively, improvement in AHD did not affect functional scores in all patients, but the only improvement was in joint ROM.
- The preoperative AHD has no prognostic value in predicting postoperative functional results in isolated supraspinatus tendon tears.

Functional Evaluation

Preoperative, American Shoulder and elbow surgeon shoulder score (ASES), and Constant-Murley scores (CMS) of the patients filtered from archives were evaluated and compared with their functional scores in the last follow-up. Along with this, physical examination tests, Jobe and drop sign that are the specific to the supraspinatus tendon, were evaluated in the preoperative and final control examinations.

Radiological Evaluation

In our clinic, true anterior–posterior (AP) radiography and MRI are routinely performed preoperatively in each patient operated for RC tear. In this study, patients were evaluated radiologically by having an MRI with true AP radiography at the last control. AHD was measured and compared on preoperative

Figure 1. AHD measurement on X-ray.

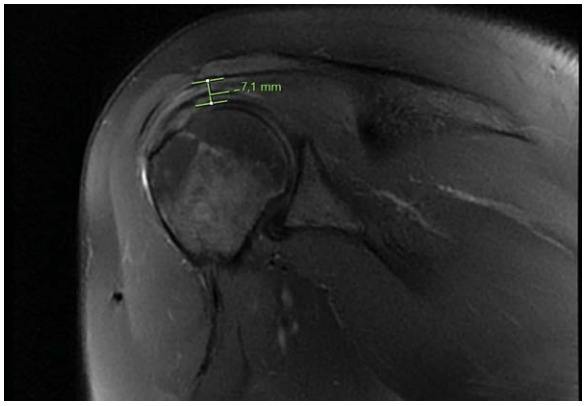
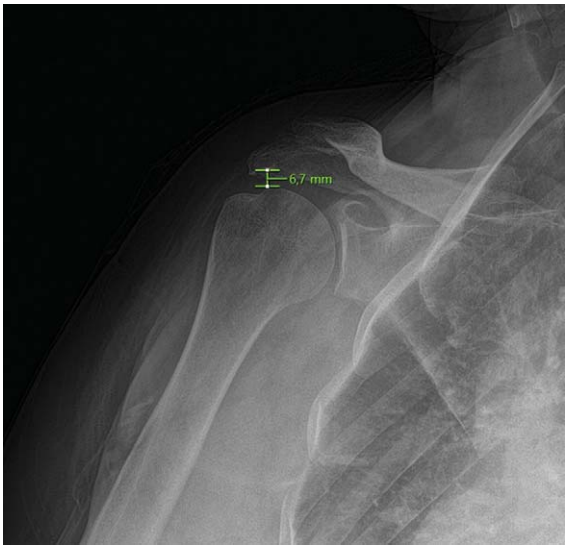


Figure 2. AHD measurement on MRI.



and postoperative radiographs and MRI. Radiographic measurements were made between the sclerotic cortical bone on the inferior face of the acromion and the most proximal narrow distance of the humeral head parallel to this line[14] (Figure 1). The reliability and accuracy of the measurement of AHD have been made according to the studies in the literature.[5,14,15] MRI was performed using a device with a 1.5 T magnetic field strength (MAGNETOM Avanto, Siemens Medical Solutions, Erlangen, Germany). These shots were made with the patient lying in the supine position, the arm in a neutral position in adduction and the forearm in pronation. AHD measurements in MRI were made by measuring the shortest distance between the top of the humeral head and the acromion in sagittal sections synchronized with T1-weighted coronal section (Figure 2). All radiological evaluations were measured separately by two observers, and average of both values was recorded.

Statistical Analysis

The data obtained were evaluated using Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM SPSS Corp.; Armonk, NY, USA) program. Normally distributed data were presented as mean ± SD, and data not normally distributed as median (IQR). The distribution of data was evaluated using Kolmogorov–Smirnov test. Student-t-test was used for normally distributed data, and Mann–Whitney U test was used for non-normally distributed data. Repeated-ANOVA and Wilcoxon's test were used to evaluate dependent groups. Chi-square test was used to evaluate categorical variables. A *P*-value of $<.05$ was considered significant in all tests.

RESULTS

The mean age was 56 years (range 41-65). Sixty-one patients were female (F) and 43 patients were male (M). Seventy-nine patients were operated on the right shoulder and 25 patients on the left shoulder. The dominant extremity was in the right side in 88 patients and in the left side in 16 patients. The average follow-up period is 28 months (19.2-34).

Preoperatively, 64.4% of the patients were positive for the Jobe test and 40.4% for the drop sign test, and all patients had a complete improvement in these tests postoperatively. Preoperative and postoperative range of motion (ROMs) of the patients are given in Table 2.

Table 2. Comparison of Preoperative and Postoperative Range of Motion

	Preoperative	Postoperative	*P*
Abduction	100° (90–120)	150° (140–160)	<.001
Flexion	140° (120–160)	160° (160–170)	<.001
Extension	45° (35–50)	50° (45–60)	<.001
Internal rotation	L4 (L5–L1)	L1 (L3–L1)	<.001
External rotation	30° (20–33.7)	40° (30–45)	<.001

Median (IQR) values are presented.
P < .05 values were considered significant.

Table 3. Comparison of the Effects of Supraspinatus Tendon Tear Level on Clinical Outcomes According to Patte Classication Frontal Plane Topography

		Group I (n = 63)	Group II (n = 41)	*P*
Age		55.25 ± 7.38	56.97 ± 5.05	.195
Gender	Female	38 (60.4%)	23 (56.1%)	.689
	Male	25 (39.6%)	18 (43.9%)	
Affected side	Right	46 (73.1%)	33 (99.4%)	.384
	Left	17 (26.9%)	8 (0.6%)	
Jobe test	Positive	33 (52.4%)	34 (82.9%)	.001*
	Negative	30 (47.6%)	7 (17.1%)	
Drop sign test	Positive	23 (36.6%)	22 (53.7%)	.026*
	Negative	40 (63.4%)	19 (46.3%)	
Preoperative Constant–Murley score		49 (41–52)	50 (42–56)	.155
Postoperative Constant–Murley score		87 (84–90)	84 (83–87)	.122
Preoperative ASES		45.55 ± 5.1	45.17 ± 3.8	.683
Postoperative ASES		86 (84–88)	84 (83–87)	.311
Preoperative abduction		100 (90–120)	100 (90–115)	.389
Preoperative exion		140 (130–160)	150 (120–160)	.659
Preoperative extension		45 (35–50)	45 (35–50)	.826
Preoperative internal rotation		L4 (L5–L3)	L4 (L5–L1)	.125
Preoperative external rotation		30 (30–30)	30 (20–35)	.882
Postoperative abduction		150 (150–170)	150 (140–160)	.005*
Postoperative exion		160 (160–180)	160 (160–165)	.032*
Postoperative extension		50 (45–60)	50 (45–55)	.110
Postoperative internal rotation		L1 (L2–L1)	L2 (L3–L2)	.053
Postoperative external rotation		50 (45–60)	50 (45–55)	<.001*

Mean ± SD and median (IQR) values are presented.
*$P < .05$ values were considered significant.

The average AHD value in the radiograms was 7.61 ± 0.7 mm for preoperative and 9.7 mm (9.1-10) for postoperative. Average AHD value in MRI examinations was 6.6 ± 0.6 mm for preoperative and 8.51 ± 0.5 mm for postoperative. Overall, a statistically significant difference was found between radiography ($P < .001$) and MRI ($P < .001$) in terms of preoperative and postoperative AHD values. The preoperative CMS was 50 (range: 42-56), and postoperative CMS was 86 (range: 84-90). The preoperative mean ASES score of the patients was 45.4 ± 4.6, and the postoperative ASES score was 86 (84-88). There was a significant improvement in all functional scores compared to preoperation (CMS, $P < .001$; ASES, $P < .001$).

Patients were divided into two groups according to the Patte classification of frontal plan topography in terms of localization of the torn stump. Group I consisted of 63 patients with insertion level (F = 38; M = 25) and group II of 41 patients (F = 23; M = 18) with stump at the level of the caput humeri. There was no significant difference between the two groups in terms of age, gender, and the affected side. Jobe and drop sign tests were significantly positive in group II. There was no significant difference between the two groups in terms of functional scores, preoperatively and postoperatively. In terms of ROM, all movements in group I have a greater range of motion than group II. There was a statistically significant improvement in group I especially in postoperative abduction, flexion, and external rotation movements (Table 3).

Table 4. Comparison of the Effects of the Supraspinatus Tendon Tear Level on the Radiological Results According to Patte Classication Frontal Plane Topography

	Group I (n = 63)	Group II (n = 41)	*P*
Preoperative AHM (X-ray)	7.98 ± 0.60	7.04 ± 0.67	<.001
Postoperative AHM (X-ray)	9.8 (9.3–10.1)	9.1 (9.0–9.7)	<.001
Preoperative AHM (MRG)	6.87 ± 0.56	6.15 ± 0.55	<.001
Postoperative AHM (MRG)	8.65 ± 0.55	8.31 ± 0.51	.003

Mean ± SD and median (IQR) values are presented.
$P < .05$ values were considered significant.

In radiological evaluation, there was a statistically significant difference in all measurements in group I compared with group II (Table 4).

DISCUSSION

Our study shows successful clinical and functional results of isolated supraspinatus tears repaired arthroscopically and their positive reflections on radiological results. It is a study in which diagnostic arthroscopic findings and MRI were evaluated together and other joint pathologies were eliminated, and patients with isolated supraspinatus tendon ruptures were evaluated.

Compared with a glenoid centered humeral head, the proximally migrated humeral head has been associated with lower ASES, CMS, restricted ROM, and lower patient satisfaction.[16–18] In recent studies about imaging methods to evaluate the displacement of the humeral head in RC tears, they evaluated the benefits of parameters such as upward migration index (UMI), inferior glenohumeral distance (IGHD), acromial index, and critical shoulder angle (CSA) other than AHD.[19–22] On the other hand, the literature regarding the clinical use of parameters such as UMI, IGHD, and CSA is not clear, AHD is still accepted as a prognostic indicator that affects functional outcome.[22]

Measurement of AHD with MRI is seen as a more practical and accurate method than X-ray. Kim et al.[19] showed that AHD measured on MRI is an independent predictor. The AHD limit value measured in MRI was accepted as ≤6 mm.[14] AHD measured by MRI is smaller than AHD measured by X-ray. MRI is performed when lying down, while the X-ray is performed when standing, and this AHD difference occurs because of gravital pull.[14,22] While MRI eliminates the position variable with standard patient positioning, it allows the distances between bony landmarks to be evaluated accurately. The radiographic mark defining the lower edge of the acromion in X-ray is a sclerotic line tangent to its lower surface. Since this line is not a fixed anatomical landmark, its location can change with changes in the direction of the X-ray. There is no such disadvantage for MRI. Werner et al.[14] found the inter method correlation coefficient r = 0.6 (moderately high) for AHD measured on X-ray and MRI. In our study, similar results were obtained between the measurements of preoperative and postoperative mean AHD by X-ray and MRI by the literature. Also, following the lower level of supraspinatus tear in group I, AHD improved postoperatively more significantly in both X-ray and MRI compared with group II.

Proximal migration of the humerus is more significant in symptomatic RC tears than in asymptomatic.[11] Correct clinical examination of the shoulder plays a crucial role in the diagnosis of RC tears. Pain, weakness, limited ROM, and various clinical tests are used for the clinical evaluation of the supraspinatus tendon. Moreover, this symptom and the ability of clinical tests to distinguish between complete and partial tears are unclear.[23,24] In a study using diagnostic arthroscopy findings, it was reported that many specific tests were unable to distinguish between partial and full-thickness tears of the supraspinatus tendon, and a combination of at least three tests was necessary for a correct diagnosis.[25] In our study, it was observed that the pain level was higher in group II (according to the pain criteria in CMS), and specific tests such as Jobe and drop sign were found to be more positive. At the same time, it was observed that preoperative AHD measurements were narrower in group II radiologically.

It has been reported that tears extending to the infraspinatus tendon are more symptomatic and associated with more proximal migration.[8–11] Weiner and Macnab[2] identified the supraspinatus tendon as the force depressing the humeral head. They stated that there is a balance between the deltoid muscle and the supraspinatus in the proximal humerus.[2] They suggested that if the supraspinatus tendon is torn, this balance is disturbed and the proximal pulling force of the deltoid muscle migrates the humeral head proximally.[2] de Oliveira França et al.[26] reported that in the frontal plane topography according to Patte classification, as the degree of tear retraction increases, AHD becomes narrower. A threshold of migration has been established in symptomatic shoulders relative to the area of the tear.[11] A tear area of 175 mm^2 fits a full-thickness tear, in which the supraspinatus tendon is slightly retracted (1 cm). Tears with an area of >175 mm^2 cause more proximal migration than smaller tears.[11] As in our study, according to the Patte classification frontal plan topography, it is clearly explained that why AHD is narrower than grade I in grade II tears. It was determined that as the degree of supraspinatus tear increased, preoperative physical examination findings and symptoms were more severe, but functional life scores did not differ significantly.

The biceps tendon has long been acting as a dynamic depressor for the humeral head.[27,28] For this reason, we decided to exclude patients with biceps tendon pathologies that play an active role in the task of depressing the humeral head in shoulders with RC tears, and patients who underwent surgery for the biceps tendon may directly affect AHD in our study.

In our study, no statistically significant difference was found between the groups in terms of preoperative overall ROM. However, postoperative shoulder abduction, flexion, and external rotation movements were found to be enormously superior to group II in group I. Extension and internal rotation, in accordance with the literature, were not significantly affected in both groups preoperatively and postoperatively.[29,30]

Our study has some limitations such as being a retrospective study and having a small sample size. Measurement bias may occur as only two orthopedic surgeons who make all measurements. Also, proximal migration was evaluated with only one parameter, AHD.

CONCLUSION

In isolated supraspinatus tears, it was observed that AHD had no effect on preoperative symptoms, ROM, and functional life scores. Postoperatively, improvement in AHD did not affect functional scores in all patients, but the only improvement was in joint ROM. It is evident that as the tear level increases following the tear level, the AHD will narrow.

As a result, the preoperative AHD has no prognostic value in predicting postoperative functional results in isolated supraspinatus tendon tears.

Ethics Committee Approval: Ethical committee approval was received from the Clinical Research Ethics Committee (20-KAEK-106).

Informed Consent: Written consent was obtained from the patients for before the surgery and postoperative final medical examination.

Peer-review: Externally peer-reviewed.

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