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RELATIONSHIP BETWEEN ANTERIOR EXTENSION OF THE ACROMION AND ROTATOR CUFF TEAR

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Abstract

The aim of this study was to investigate the relationship between anterior acromial extension beyond the clavicle and the presence of rotator cuff tears. Images of 1156 patients who underwent shoulder MRI examination due to shoulder pain were reviewed. Two groups were formed from 284 patients included in the study. Group 1 included 142 patients with anterior acromial extension beyond the clavicle, whereas Group 2 consisted of 142 patients without anterior acromial extension. The presence of a rotator cuff tear was recorded in all patients. The relationship between the size of the acromion's anterior extension and rotator cuff tear was statistically evaluated. In Group 1, the length of the anterior acromial extension was found to be an average of 7.7 mm (95% CI for median 6.8–8.5 mm). Anterior acromial extension was significantly associated with a higher incidence of rotator cuff tears compared with the control group ($p < 0.001$). Supraspinatus and subscapularis tears were more frequent in Group 1 ($p = 0.020$ and $p = 0.011$, respectively). During forward elevation, the contact between the acromion and the rotator cuff becomes more pronounced especially in cases with a prominent anterior acromial extension. This could potentially lead to inflammation in the rotator cuff, particularly in the supraspinatus and subscapularis muscles, and the method used in our study to measure anterior acromial coverage is relatively simple and reliable.

Key words: subacromial impingement, rotator cuff, acromion, acromion shape, rotator cuff tear, shoulder, shoulder pain

Level of evidence: Level III

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Introduction. Rotator cuff tears are a common shoulder problem in adults. They are observed in 25% of individuals over the age of sixty and can reach 50% in those over eighty [1]. The exact cause of rotator cuff tears is still not fully understood. Theories and discussions continue regarding whether tears occur due to degeneration within the tendon itself or as a result of contact and irritation with the structures surrounding the tendon [2].

The relationship between acromion morphology and rotator cuff tears has been noted. In 1986, Bigliani classified acromion morphology into three types and emphasized the relationship between type 3 acromion and rotator cuff injuries [3, 4]. Subsequently, an increase in acromion index or a critical shoulder angle greater than 35 degrees has been highlighted as a risk factor for rotator cuff injuries [5, 6]. Our theory is based on the fact that in daily life, people often perform shoulder movements above shoulder level, especially in the form of shoulder elevation. During shoulder elevation, the anterior extension of the acromion can come into contact with the rotator cuff. This contact is especially evident when the acromion is significantly longer anteriorly. The aim of this study is to determine whether excessive length of the anterior extension of the acromion is associated with the frequency of rotator cuff tears.

Methods. This study was carried out at Giresun University Medical Faculty in Turkey from 2019 to 2023. It is a retrospective, single-centre, randomized controlled clinical study. The study protocol was conducted in accordance with the World Medical Association Declaration of Helsinki ethical principles and approved by the Institutional Ethics Committee of Giresun University Faculty of Medicine Training and Research Hospital.

Patient data were collected from the hospital information system. The MRI images of 1156 patients who presented to our hospital between January 2019 and January 2023 with shoulder pain and underwent magnetic resonance imaging (MRI) were retrospectively reviewed.

Patients with congenital shoulder malformations and those with a history of shoulder tumours, infections, fractures, adhesive capsulitis, calcific tendinitis, trauma, and surgical interventions were excluded from the study. A total of 284 patients remained in the study.

All MRI examinations were performed using the same 1.5T MRI system (Magneton Symphony; Siemens Medical Solutions, Erlangen, Germany) with a phased array shoulder coil. Patients were placed in a supine position with their arms at their sides in partial external rotation. The acromial anterior protrusion (AAP) was measured on axial images. The acromiohumeral distance (AHD) was measured on the coronal section of T1 MRI as the distance between two parallel lines tangential to the apex of the humeral head and the inferior cortex of the acromion. The patients were divided into two groups based on whether the anterior extension of the acromion passed the anterior edge of the clavicle (Group 1) or not (Group 2).

Patient age, gender, side of the shoulder joint, and the presence of any additional diseases (diabetes, hypertension, hypothyroidism, inflammatory rheumatoid arthritis, connective tissue diseases, and long-term steroid use, etc.) were recorded.

Measurement of the acromion's anterior extension. In the MRI images of the shoulders, measurements were made from the transverse sections at the level where the acromion and clavicle were most clearly seen. In this image, a horizontal line was drawn from the distal end of the clavicle towards the acromion. Then, the size of the anterior extension of the acromion in front of this line was measured (Fig. 1, 2).

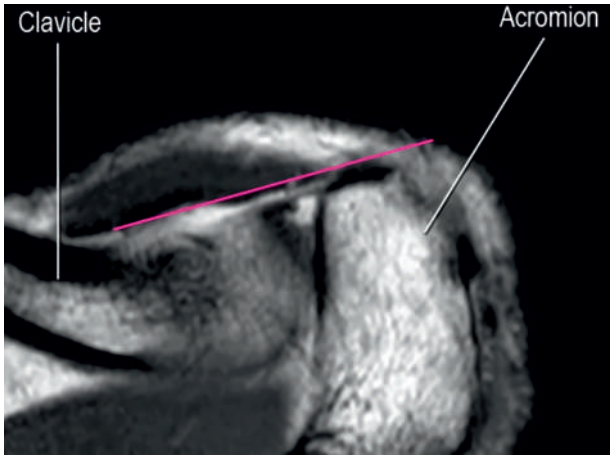


Fig. 1. MRI image where the anterior of the acromion does not extend beyond the anterior edge of the clavicle (Group 2)

The presence of a rotator cuff tear was noted in all cases. If a rotator cuff tear was present, the size, location, and whether it was partial or full thickness were recorded. In the control group, which did not have an anterior projection of the acromion beyond the anterior edge of the clavicle, shoulder MRI scans were evaluated for the presence of a rotator cuff tear. Similarly, if a rotator cuff tear was present, its location, size, and whether it was partial or full thickness were recorded. Additionally, in the shoulder MRI examinations of all patients, the acromiohumeral distances and the acromion types described by Bigliani [4] were also evaluated and noted.

Measurement of the acromiohumeral interval (AHI). The distance between the inferior surface of the acromion and the superior part of the humeral head was measured. The relationship between the acromiohumeral distance and rotator cuff tear, as well as the relationship between the anterior extension of the acromion and these distances, were recorded.

Statistical analysis. All statistical analyses were performed using SPSS software (ver. 22.0; SPSS, Inc., Chicago, IL). For intergroup comparisons, the

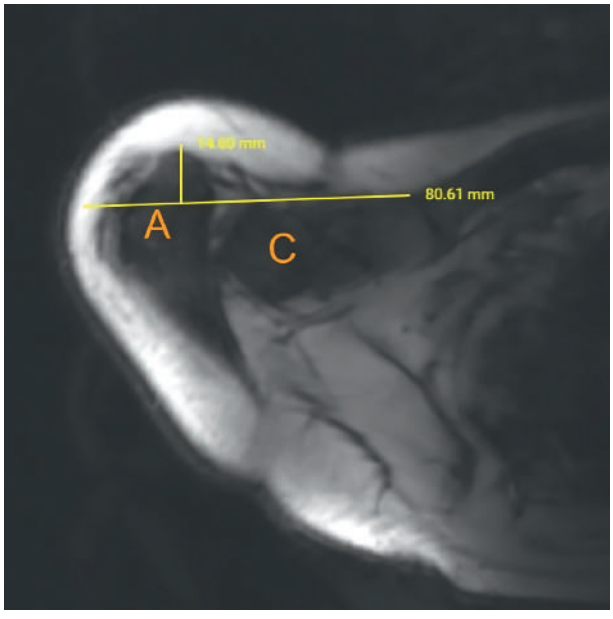


Fig. 2. The anterior tip of the acromion extends 14.60 mm in front of the clavicle in the MRI image (Group 1). A: acromion, C: clavicle

probability ratio of the presence of a rotator cuff tear in cases with an anterior extension of the acromion was calculated at a 95% confidence interval (CI). The group with an anterior extension of the acromion and the control group were compared according to age, gender, comorbidities (diabetes mellitus, hypothyroidism, inflammatory/crystal arthritis, connective tissue disease), side of the shoulder (left, right), incidence of rotator cuff tear (present, absent), size of rotator cuff tear (full or partial thickness), and location of rotator cuff tear (supraspinatus, infraspinatus, subscapularis) variables. These comparisons were made using the Student's t-test for continuous variables and the chi-square test for categorical variables. The relationship between acromion projection and rotator cuff tear was evaluated using Spearman's rho parametric correlation test. A p-value of < 0.05 was considered statistically significant.

Results. All measurements were independently performed by a musculoskeletal radiology specialist (İÇ) and an orthopedist (CE) who specialized in shoulder surgery. Interobservers ($< 5\%$) and interobserver ($> 87\%$) variability analysis found high interobservers concordance for the parameters.

The average age of 284 retrospectively evaluated patients was determined to be 57.87. There was no significant difference in the ages of patients in the groups. When evaluated by gender, out of 284 patients, 166 (58.2%) were female and 118 (41.7%) were male. Statistically significant difference was observed between the groups. In Group 1 cases, the average length of the anterior extension of the acromion in front of the clavicle was found to be 7.7 mm (95% CI for median 6.8–

Table 1

Demographic data of the groups

	$n = 284$	Group with anterior extension of the acromion Group 1 ($n = 142$)	Control group Group 2 ($n = 142$)	p
Age (year) mean	57.82 ± 10.4	57.95 ± 7.8	57.7 ± 8.9	0.81
Sex (%)				0.004
Female	166 (58.2%)	78	88	
Male	118 (41.7%)	64	54	
Side (n)				<0.001
Left	76	20	56	
Right	208	122	86	
Rotator cuff tear (n)				
No	104	34	70	
Yes	180	108	72	<0.001

8.5 mm). Table 1 grouped patients based on the presence of acromion projection and the presence of a rotator cuff tear.

The localization of tears and whether they were partial or full thickness were determined. The presence of an anterior projection of the acromion in patients with rotator cuff tears was significantly associated with a median of 95% CI; 6.8–8.3 mm ($p < 0.001$). In the group with an anterior extension of the acromion (Group 1), the incidence of tears in the supraspinatus and subscapularis was statistically higher than in the control group ($p = 0.020$ and $p = 0.011$, respectively) (Table 2).

Of the 142 patients with an anterior extension of the acromion, 108 had a rotator cuff tear, with 60 having type I acromion (42.3%), 70 having type II acromion (49.3%), 10 having type III acromion (7%), and 2 having type IV acromion (1.4%). Among the 142 patients without an anterior extension of the acromion, 72 had a rotator cuff tear, with 68 having type I acromion (47.9%), 58 having type II acromion (40.8%), 10 having type III acromion (7%), and 6 having type IV acromion (4.2%).

The acromiohumeral distance was measured as 7.7 mm in the group with an anterior extension of the acromion (95% CI for median; 7.4–8 mm). In the group without an anterior extension of the acromion, the acromiohumeral distance was measured as 8 mm (95% CI for median; 6.8–8.3 mm). There was no significant difference in acromiohumeral distance between patients with an anterior extension of the acromion and those without ($p = 0.505$).

Discussion. The anatomical variations of the acromion and their association with impingement of the rotator cuff tendons have long been described [7–9].

Table 2

Frequency of rotator cuff tears with anterior acromion projection

Anterior acromion projection		**No**	**Yes**	***p*-value**
Sex		57.95	57.7	0.945
Rotator cuff tear	No	70	34	
	Yes	72	108	
Supraspinatus tear	Partial	26	52	0.020
	Full thickness	24	44	
Subscapularis tear	Partial	26	320	0.011
	Full thickness	8	22	
Infraspinatus tear	Partial	16	20	0.094
	Full thickness	8	24	
Acromion type	1	68	60	0.305
	2	58	70	
	3	10	10	
	4	6	2	
Acromiohumeral interval		8 (7.8–8.3)	7.7 (7.4–8)	0.505

Neer first described the term "impingement syndrome" and emphasized that in impingement syndrome, the rotator cuff comes into contact with the inferior aspect of the anterior acromion [7, 8]. Thus, he described the inferior acromioplasty performed by cutting the inferior part of the anterior acromion [7]. Today, this is a fundamental technique in arthroscopic acromioplasty. In 1974, Rockwood [9] observed that in some cases where Neer acromioplasty was performed (trimming the anterior inferior part of the acromion), impingement symptoms continued. When he re-operated these patients, he found that the anterior acromion extension that passed beyond the anterior edge of the clavicle was excessively long. During flexion of the arm, the excessively long anterior part of the acromion during forward flexion compresses the rotator cuff. Therefore, he described a two-step acromioplasty [9]. In the first step, the extension of the acromion in front of the anterior edge of the clavicle is cut. In the second step, the remaining anterior part of the acromion is cut inferiorly.

Yamamoto et al. [10] emphasized that acromion morphology is associated with rotator cuff injury. Similarly, in a large case-number meta-analysis conducted by Morelli et al. [11] it was demonstrated that acromion morphology is directly associated with rotator cuff rupture. Zeng et al. [1] highlighted that anteromedial injuries of the rotator cuff may be associated with an inferior projection or anterior extension. They measured the anterior extension using a 3D model. They observed that anterior extension was more common with type III acromion. In cases with these protrusions, the risk of rotator cuff injury is increased.

The relationship between critical shoulder angle and rotator cuff rupture has been explained multiple times. In a study conducted by Tütüncü et al. [12] on 100 patients, the critical shoulder angle (CSA) was measured. This angle is defined as the angle between the glenoid joint and the lateral acromial extension in the coronal plane. An increased CSA ($\geq$ 30–35°) has been found to be associated with rotator cuff rupture. Measurement of this angle always varies depending on the clinician performing the measurement and whether the radiographic imaging is obtained in the correct position. In our study, instead of measuring any angle, the anterior portion of the acromion extending beyond the anterior clavicle was measured on MRI and compared with the control group. The presence of an acromial extension exceeding the anterior clavicle length (7.7 mm in our study) was again found to be associated with rotator cuff rupture.

In the study conducted by Kim et al. [13] on 356 patients, the lateral and anteroposterior coverages of the acromion were evaluated using measurements including the anteroposterior coverage index (APCI), acromial tilt (AT), lateral acromial angle (LAA), critical shoulder angle (CSA), and acromiohumeral interval (AHI). It was demonstrated that an increased APCI angle is associated with rotator cuff tears. Measuring this angle often requires three-dimensional computed tomography, and the measurements tend to show intra-observer variability, making angle measurement more inconsistent. In our study, a single linear measurement was performed on axial-plane MRI, which is considered a simpler measurement method. Indeed, in our study, the acromial projection exceeding the anterior border of the clavicle was calculated using a simple length measurement, and this was also found to be associated with rotator cuff tears.

The acromiohumeral distance indicates the superior displacement of the humeral head. In massive rotator cuff tears, the humeral head is displaced superiorly, and the acromiohumeral distance decreases [14]. The evaluation of the acromiohumeral distance is mostly done with direct radiographs and MRI examinations [1]. In our study, no significant difference was observed in the acromiohumeral distance between the groups.

In our hypothesis, in daily life, people extend their arms forward to reach high objects above shoulder level. When the shoulders are raised above shoulder level, the front part of the acromion comes into closer contact with the rotator cuff. Therefore, it can irritate the rotator cuff and potentially lead to tears. In our study, it was determined that the presence of an anterior extension of the acromion in the group with this extension was statistically significantly higher in terms of the incidence of rotator cuff tears compared to the group without an anterior extension of the acromion. More specifically, the affected muscles of the rotator cuff are the supraspinatus and the subscapularis.

Limitations. The sample size may not be sufficient to establish a relationship between the anterior extension of the acromion and rotator cuff tears in this study. Clinical conditions of the shoulder, such as shoulder instability, range of

motion, the degree and duration of pain, were not analyzed. Our study evaluated the relationship between the condition of the tendon at the time of MRI and the length of the anterior extension of the acromion.

Conclusion. In this study, we concluded that the anterior extension of the acromion in front of the clavicular anterior edge may be associated with rotator cuff injuries. Furthermore, our measurement method of anterior acromial coverage is relatively simple and reliable.

Authors contributions. ET contributed to the study design, data collection and analysis, manuscript writing, and revisions; CZE contributed to the literature review, data analysis and interpretation, manuscript writing, data collection and analysis, and manuscript revisions; TK contributed to the data interpretation, manuscript writing, data analysis; BY contributed to the data interpretation, manuscript writing, and manuscript revisions; İÇ contributed to data collection, analysis and interpretation.

REFERENCES

[1] Zeng Y. M., C. Xu, K. Zhang et al. (2020) Prediction of rotator cuff injury associated with acromial morphology: a three-dimensional measurement study, Orthop. Surg., **12**(5), 1394–1404.

[2] Petik B. (2022) Correlation of acromial shape and rotator cuff tears using magnetic resonance imaging, Turk. J. Vasc. Surg., **11**(3), 1264–1267.

[3] Armstrong J. R. (1949) Excision of the acromion in treatment of the supraspinatus syndrome; report of 95 excisions, J. Bone Joint Surg. Br., **31B**(3), 436–442.

[4] Bigliani L. U., J. B. Ticker, E. L. Flatow et al. (1991) The relationship of acromial architecture to rotator cuff disease, Clin. Sports Med., **10**(4), 823–838.

[5] Kaiser D., E. Bachmann, C. Gerber, D. C. Meyer (2018) Influence of the site of acromioplasty on reduction of the critical shoulder angle (CSA) – an anatomical study, BMC Musculoskelet. Disord., **19**(1), 371.

[6] Nyffeler R. W., C. M. L. Werner, A. Sukthankar et al. (2006) Association of a large lateral extension of the acromion with rotator cuff tears, J. Bone Joint Surg., **88**(4), 800–805.

[7] Neer C. S. 2nd (1972) Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report, J. Bone Joint Surg. Am., **54**(1), 41–50.

[8] Neer C. S. 2nd, E. V. Craig, H. Fukuda (1983) Cuff-tear arthropathy, J. Bone Joint Surg. Am., **65**(9), 1232–1244.

[9] Rockwood C. A., F. R. Lyons (1993) Shoulder impingement syndrome: diagnosis, radiographic evaluation, and treatment with a modified Neer acromioplasty, J. Bone Joint Surg. Am., **75**(3), 409–424.

[10] Yamamoto A., K. Takagishi, T. Osawa et al. (2010) Prevalence and risk factors of a rotator cuff tear in the general population, J. Shoulder and Elbow Surg., **19**(1), 116–120.

[11] Morelli K. M., B. R. Martin, F. H. Charakla et al. (2018) Acromion morphology and prevalence of rotator cuff tear: A systematic review and meta-analysis, Clin. Anat., **32**(1), 122–130.

[12] Tütüncü M. N., Y. Kültür, M. K. Özşahin, N. Aydin (2024) Role of critical shoulder angle in degenerative type rotator cuff tears: a Turkish cohort study, Med. Sci. Monit., **30**, e943703.
[13] Kim M.-S., S.-M. Rhee, H. J. Jeon, Y.-G. Rhee (2022) Anteroposterior and lateral coverage of the acromion: prediction of the rotator cuff tear and tear size, Clin. Orthop. Surg., **14**(4), 593–602.
[14] Toivonen D. A., M. J. Tuite, J. F. Orwin (1995) Acromial structure and tears of the rotator cuff, J. Shoulder Elbow Surg., **4**(5), 376–383.

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