Research Article / Araştırma Makalesi

Could Some Measurements of the Scapula be Related to Rotator Cuff Syndrome?

Scapula ile İlgili Bazı Ölçümler Rotator Cuff Sendromu ile İlgili Olabilir mi?

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Abstract

Background: The scapula plays an important role in shoulder movements and stability of the shoulder. In addition, the dimensions of the scapula and some anatomical measurements are very important in the pathomechanics of rotator cuff syndrome, total shoulder arthroplasty and recurrent shoulder dislocation. The aim of this study is to determine the morphometry of the scapula and to investigate with the relationship between rotator cuff syndrome.
Materials and Methods: This study was a retrospective, observational study, and a total of 232 radiographs, 125 of which were male and 107 were female, were analyzed. The patients were analyzed in two main groups: Patients with rotator cuff syndrome (116 patients) and patients with no history of shoulder problems (116 patients). 9 different parameters were measured: The maximum scapular length and width, the scapular index, the maximum glenoid cavity length and width, the glenoid cavity index, the length of acromion, the distances between the acromion and coracoid process and length of the spina scapula.
Results: The maximum scapular length (p=0.037), the maximum glenoid cavity length (p=0.009) and the length of spina scapula (p=0.041) were significantly different between the rotator cuff and control groups in evaluating parameters. All parameters were significantly different between male and female patients (p<0.05).
Conclusion: It is necessary to know the anatomy of the scapula in detail in order to be successful in surgical treatments involving the scapula and shoulder and in total shoulder arthroplasty. We think that the measurements of acromion, glenoid and scapula sizes obtained from our study will help surgeons to better understand shoulder morphology and to decide on the appropriate glenoid component size for shoulder arthroplasty. The fact that the lengths of the scapula, glenoid cavity and spina scapula are significantly different in rotator cuff syndrome suggests that the morphometry of the scapula may be effective in rotator cuff syndrome.

Key Words: Acromion, Glenoid, Morphometry, Radiography, Scapula

Öz

Amaç: Scapula, omuz hareketi ve stabilitesinde benzersiz bir rol oynar. Ayrıca scapula'nın boyutları ve bazı anatomik ölçümleri, rotator cuff sendromu, total omuz artroplastisi ve tekrarlayan omuz çıkığının patomekaniğinde çok önemlidir. Bu çalışmanın amacı scapula'nın morfometrik ölçümlerini belirlemek ve rotator cuff sendromu ile ilişkisini araştırmaktır.
Materyal ve Metot: Bu çalışma 125 tanesi erkeğe ve 107 tanesi kadına ait olmak üzere toplam 232 radyografi görüntüsünün incelendiği retrospektif ve gözlemsel bir çalışmadır. Hastalar rotator cuff sendromu olan (116 hasta) ve omuz problemi olmayan hastalar (116 hasta) olmak üzere iki gruba ayrılarak incelendi. 9 farklı parametre ölçüldü: Maksimum scapular uzunluk, maksimum scapular genişlik, scapular indeks, maksimum cavitas glenoidalis uzunluğu, maksimum cavitas glenoidalis genişliği, cavitas glenoidalis indeksi, acromion uzunluğu, acromion ile processus (proc.) coracoideus arasındaki mesafe ve spina scapula uzunluğu.
Bulgular: Parametrelerin değerlendirilmesinde rotator cuff sendromu olan ve herhangi bir omuz problemi olmayan gruplar arasında maksimum scapular uzunluk (p=0, 037), maksimum cavitas glenoidalis uzunluğu (p=0,009) ve spina scapula uzunluğu (p=0,041) anlamlı olarak farklıydı. Tüm parametreler erkek ve kadın hastalar arasında anlamlı olarak farklıydı (p<0,05).
Sonuç: Scapula ve omuzu içeren cerrahi tedavilerde ve total omuz artroplastisinde başarı elde etmek için ayrıntılı bir şekilde scapula anatomisinin bilinmesi gereklidir. Çalışmamızdan elde edilen acromion, glenoid ve scapula boyutlarının ölçümlerinin cerrahların omuz morfolojisini daha iyi anlamalarına ve omuz artroplastisi için uygun glenoid komponent boyutuna karar vermelerine yardımcı olacağını düşünüyoruz. Rotator cuff sendromunda scapula, cavitas glenoidalis ve spina scapula uzunluklarının anlamlı derecede farklı olması rotator cuff sendromunda scapula morfometrisinin etkili olabileceğini düşündürmektedir.

Anahtar Kelimeler: Acromion, Glenoid, Morfometri, Radyografi, Scapula

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Introduction

The scapula is a flat, triangular bone that forms the shoulder girdle and connects the upper extremity to the trunk. It is located on the posterolateral side of the thoracic cage (1, 2). Scapula have a complex anatomy due to their specific irregular shape. This triangular bone has two surfaces, three margins, three angles, and three bony prominences (spine, acromion and coracoid process). Due to this irregular shape, its anatomical structure is complex (3). The glenoid cavity, which articulates with the humeral head and forms the glenohumeral joint, is located at the lateral angle of the scapula. The glenohumeral joint is stabilized by the rotator cuff muscles, tendons, ligaments, and the glenoid labrum. This joint provides the mobility of the upper extremity and allows it to move in many directions. In particular, the rotator cuff muscles cover the capsule of the glenohumeral joint, fixing the joint and contributing to motion in the acromioclavicular joint (4). The wide range of motion of the joint predisposes the joint to damage and arthropathy (1). It is necessary to know the detail anatomy of the scapula in surgical procedures related to the scapula and shoulder. In addition, knowing whether the morphometric differences of the scapula vary according to race or gender is very important in some clinical fields, especially in forensic medicine. However, despite its importance, there are very limited studies for morphometric dimensions of scapula in the literature (5, 6).

In order to interpret pathological changes in the shoulder joint, which is the most mobile joint in the body, it is necessary to know its normal anatomical structure and to know the radiography examination techniques. The aim of this study is to determine the morphometry of the scapula and to reveal with the relationship between rotator cuff syndrome.

Materials and Methods

This study was a retrospective, observational study and it was carried out on 232 (125 male and 107 female) patients who had shoulder radiographs between January 2019 and December 2020. This study was approved by Alanya Alaaddin Keykubat University non-interventional clinical research ethics committee (Date: 13/01/2021; Decision No: 2021:01–27). After obtaining ethical approval, all measurements were taken electronically on radiographs displayed on a PACS. 232 radiographs of the shoulders were reviewed. The parameters were measured 3 times by a single researcher and averaged. All patients with previous shoulder fractures, infections, and tumors were excluded.

The patients were analyzed in two main groups: (Group 1) Patients with rotator cuff syndrome (116 patients) and (Group 2) Patients with no history of shoulder problems (116 patients): Radiographs of the patients in this group were taken for routine examinations and controls.

We measured 9 different parameters:

- The maximum scapular length (SCL) was measured (distance between the most superior point of the superior margin of the scapula and the most inferior point on the angulus inferior) (Fig 1A),
- The maximum scapular width (SCW) was measured (distance between the most inferior point of the glenoid cavity and point of intersection of spine to the medial border of the scapula) (Fig 1B),
- The scapular index (SI) was calculated as follow: SCW/SCL.
- The maximum glenoid cavity length (GL) (distance between the most superior point and the most inferior point of the glenoid) (Fig 2A),
- The maximum glenoid cavity width (GW) (distance between the anterior margin and posterior margin of the glenoid) were measured (Fig 2A),
- And the glenoid cavity index (GI) was calculated as follows: GW/GL.
- We measured the length of acromion (AL) (Fig 2B), the distances between the acromion and coracoid process (ACP) (Fig 2B) and length of spina scapula (LSP).

Statistical analysis

The SPSS 21.0 program was used for statistical analysis. All measurements, means and standard deviations (SD) values were calculated. Moreover, they were tested for correlation to each other sex and group. "Kolmogorov-Smirnov" and "Shapiro-Wilk" tests were performed to determine whether the data were suitable for normal distribution. In the evaluation of parameters according to gender and syndrome, the independent t-test was used for those who did show typical distribution characteristics. All values are mean ± standard error mean (SEM) was given. A p-value under 0.05 was considered statistically significant in all statistical analyses ($p<0.05$).

Results

Two hundred thirty-two shoulders were studied in this paper. The mean age was 52 years (53 years in female and 51 years in male patients). The overall mean ± SEM of the SCL, SCW, GL and GW of the male scapulae were 163.5 ± 1.13 mm, 87.6 ± 0.90 mm, 48.13 ± 3.24 mm and 26.62 ± 0.27 mm, respectively, and 138.27 ± 0.86 mm, 76.73 ± 0.74 mm, 38.91 ± 0.30 mm and 23.82 ± 0.25 mm, respectively, in the female specimens. There was significant difference of SI and GI were in male and female specimens as; 0.53 ($p = 0.005$); 0.58, ($p=0.005$) and 0.55 ($p = 0.006$); 0.60, ($p=0.006$) respectively. The overall mean ± SEM of AL, ACP and LSP of the male were 33.31 ± 0.45 mm, 27.66 ± 0.37 mm and 139.61 ± 8.75 mm and 28.33 ± 0.39 mm, 25.65 ± 0.45 mm and 114.73 ± 0.81 mm, respectively, in the female specimens. The male dimensions of the scapula and glenoid cavity were significantly larger than those of the female scapulae ($p < 0.05$; Table 1).

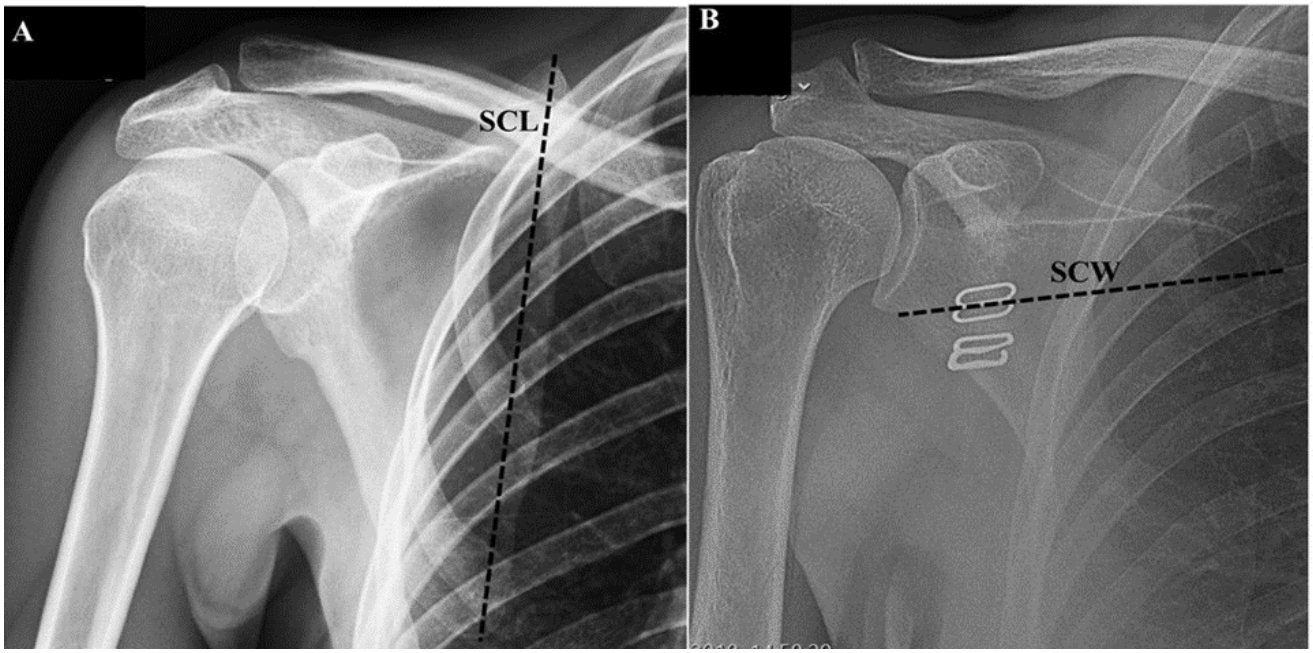

Figure 1. Measurements of the scapula.
(A) SCL: Length of the scapula, (B) SCW: Width of the scapula

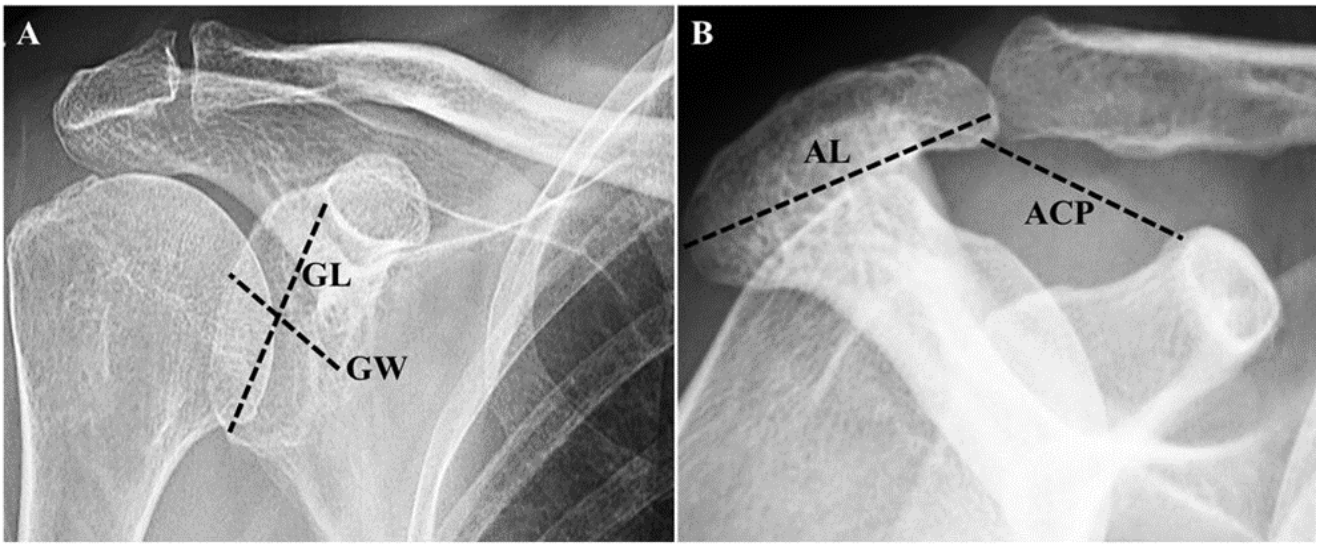

Figure 2. Measurements of the glenoid cavity and acromion.
(A) GL: Length of the glenoid cavity, GW: Width of the glenoid cavity. (B) AL: Length of the acromion, ACP: The distances between the acromion and coracoid process

Table 1: Mean values of measurements of the scapula according to gender and syndrome

Parameters of the scapula (mm)	Male	Female	Rotator cuff syndrome	Control
SCL	163.5 ± 1.13	138.27 ± 0.86	153.55 ± 1.43	150.24± 1.67
SCW	87.6 ± 0.90	76.73 ± 0.74	83.12± 0.92	82.13±1.04
SI	0.53±0.005	0.55±0.006	0.53±0.005	0.54±0.006
GL	48.13 ± 3.24	38.91 ± 0.30	45.84±3.52	41.91±0.43
GW	26.62 ± 0.27	23.82 ± 0.25	25.59±0.26	25.06±0.32
GI	0.58±0.005	0.60±0.006	0.60±0.005	0.59±0.006
AL	33.31 ± 0.45	28.33 ± 0.39	31.35±0.46	30.66±0.50
ACP	27.66 ± 0.37	25.65 ± 0.45	26.75±0.42	26.71±0.41
LSP	139.61 ± 8.75	114.73 ± 0.81	124.60±1.15	131.67±9.52

p<0.05, differences between groups, (mean± standard error mean)
SCL: Maximum scapular length, SCW: Maximum scapular width, SI: Scapular index, GL: Maximum glenoid cavity length, GW: Maximum glenoid cavity width, GI: Glenoid cavity index, AL: Length of acromion, ACP: Distances between the acromion and coracoid process, LSP: Length of spina scapula

Table 2. Comparison of the parameters of the scapula between studies (mean)

Parameters (mm)	Present Study	Polguj 2011	Coskun 2006	Chaijaroonk 2018	Boyan 2018	Guo 2018	Vassallo 2021	Kaledzera 2022	Azhagiri 2022	Ulkır 2022	Takayama 2022	Zhou 2022
SCL	152	156	99	148	-	-	158	146	149	-	148	-
SCW	83	99	-	108	-	-	107	100	103	-	-	-
SI	0.54	0.63	-	-	-	-	-	-	-	-	-	-
GL	44	39	36	37	-	-	41	-	35	37	42	33
GW	25	28	25	27	-	-	30	-	24	26	31	26
GI	0.59	0.72	-	-	-	-	-	-	-	-	-	-
AL	31	45	-	-	42	41	-	-	46	-	-	-
ACP	27	-	-	-	38	-	-	-	42	-	-	-
LSP	128	132	-	-	-	111	-	-	-	-	108	-

SCL: Maximum scapular length, SCW: Maximum scapular width, SI: Scapular index, GL: Maximum glenoid cavity length, GW: Maximum glenoid cavity width, GI: Glenoid cavity index, AL: Length of acromion, ACP: Distances between the acromion and coracoid process, LSP: Length of spina scapula

The mean values of the parameters according to the syndromes are given in Table 1. According to syndromes, the SCL (p=0.037), the GL (p=0.009) and the LSP (p=0.041) were significantly different between the rotator cuff and control groups in evaluating parameters. All parameters were significantly different between male and female patients (p<0.05).

Discussion

Due to its location and shape, the scapula plays an important role in shoulder movements and stabilization of the shoulder joint (7). In addition, the dimensions and morphometric features of the scapula are important in the pathomechanics of rotator cuff disease and total shoulder arthroplasty (8). Generally, varying numbers of dry scapula was used for measurement in previous studies. Polguj et al. (9) were used 86 dry scapulae, Chaijaroonkhanarak et al. were used 264 dry scapulae (1), Guo et al. were used 292 dry scapula (10), Boyan et al. were used 73 dry scapula (3), Coskun et al. were used 90 dry scapula (7), Kaledzera et al. were used 125 dry scapula (11), Azhagiri et al. were used 100 dry scapula (12). Vassallo et al. were used 180 dry scapula to establish population-specific discriminant functions (Table 2). All measurements were sexually dimorphic, as a significant mean difference (p < 0.001) in size was found. They stated that in the Italian population, the left and right side of each scapular measurement demonstrated statistically significant mean size differences between males and females, indicating that the scapulae are sexually dimorphic (13).

And there are few studies using radiography images to determine the morphometric dimensions of the scapula. Ulkır et al. investigated 200 CT scans of the scapula for contribute to sex determination studies from the scapula in the Turkish population. In their study measurements of parameters were found higher at male scapula than female scapula (14). Takayama and Ito were investigated a total of 223 patients underwent CT of the shoulder joint during their study period (15). Smith et al. investigated 53 patients who had CT examination of the shoulder joint (16). Zhou et al. were studied glenoid parameters measured from skeletal scapula specimens with those measured by 3D modeling of CT scanning images (17). Ghafurian et al. in their study, they performed an automated analysis of the glenoid orientation based on 3D surface data. They were analyzed three-dimensional models of 12 scapulae (18). Chen et al. were used bilateral shoulder radiology of 120 patients (19) (Table 2).

We measured some scapula-related parameters in radiographic images to compare the measurements of the dry scapula and the measurements of the radiographic images, as well as to compare the measurements of individuals with rotator cuff syndrome and healthy individuals. At the same time, our study differs from dry scapula studies as gender determination could not be made and pathological condition could not be evaluated in previous studies. First measurement is the length of the scapula and our results reveals similarities with some studies in the literature (Table 2). Length of the scapula was significantly higher in male patient than female patients and this measurement was significantly higher (p=0.037) in patients with rotator cuff syndrome than control patients (Table 1). The sex determination study from scapula was first performed by Dwight in 1894 and measured the length of the glenoid cavity and maximum scapular length. If the maximum scapular length was greater than 170 mm, the scapula was determined as male scapula and it was smaller than 140 mm, the scapula was determined as female scapula. He said that maximum scapular length is an effective parameter in sex determination from the scapula (14). Also in cases of shoulder arthroplasty, it is also easy to determine the dimensions of glenoid using the length and width of the scapula based on the anteroposterior view of the shoulder radiography. In the light of these data, we think that morphometric measurements of the scapula are a distinguishing parameter both in rotator cuff syndrome and in determining gender.

Radiographic evaluation and measurement indices can comprehensively reflect the shoulder joint cavity. Knowing the dimensions of the glenoid cavity provides important information for attaching the glenoid component in shoulder arthroplasty (20). In cases of glenoid reconstruction surgery, normal glenoid dimensions can be predetermined using the length and width of the scapula. This will help to perform the operation without any complications. Also allowing the surgeon to preoperatively determine the size and shape of the bone graft for glenoid reconstruction (1). Length of the

glenoid cavity was significantly higher in male patient than female patients and this measurement was significantly higher (p=0.009) in patients with rotator cuff syndrome than control patients in this study (Table 1). Zhou et al. were reported that the median manual measurements of GW and GL were 24 mm and 36.5 mm respectively, while the corresponding CT measurements were 26 mm and 33 mm respectively. Also they stated that there is no significant difference between direct manual and CT measurements of the glenoid (17). Ghafurian et al. were reported that glenoid inclination was measured both relative to transverse axis of the scapula and the medial pole-inferior tip axis. They found that the mean of the glenoid version was 0.55 consistent with this study (18). Glenoid reconstruction is one treatment for glenoid bone loss causing recurrent shoulder dislocation (1). The relationships between the size and inclination of the glenoid cavity during shoulder reconstruction surgery are an important guide for orthopedic surgeons (21).

The AL was found 33 mm in male, 28 mm in female, 31 mm in rotator cuff patients and 30 mm in control patients in this study. Chen et al. were reported that AL was 30 mm consistent with this study and significantly different between the left and right sides. They were also reported that the AL measured on the right side was larger than that on the left, which may be related to right-handedness (19). Smith et al. were stated that the acromion and the glenoid inclination are the most important predictive variables (16). It was reported that the increased length of the acromion limits the overhead activities (7). It has been observed that when the acromion length is greater than its normal values, it affects the pectoral junction and restricts the movements of the upper extremity. Good knowledge of the morphometric dimensions of the acromion helps surgeons define bony landmarks (3).

Evaluation of morphometric data, which provides an anatomical basis for the scapula, will be useful in surgical and arthroscopic procedures in the shoulder joint (20). A detailed knowledge of the anatomy of the scapula is very important for success in shoulder arthroplasty, related surgical procedures of the scapula and shoulder (22). Also at shoulder arthroscopy the distance of certain structures from palpable bony landmarks is vital to determine entrance points (3). We think that the measurements of the glenoid cavity, acromion and scapula sizes obtained from our study will help surgeons to better understand shoulder morphology and to decide on the appropriate glenoid component size for shoulder arthroplasty. The fact that the lengths of the scapula, glenoid cavity and spina scapula are significantly different in rotator cuff syndrome suggests that morphometry of the scapula may be effective in rotator cuff syndrome.

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Design : B.C.

Data acquisition: B.C.

Analysis and interpretation: B.C.

Writing manuscript: B.C.

Critical revision of manuscript: B.C., E.T.

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