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Association between shoulder coracoacromial arch morphology and anterior instability of the shoulder

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Background: Glenohumeral instability is a common condition of the shoulder. Glenoid bone loss and humeral head bone loss are well recognized as risk factors for recurrent instability. There are few studies in the literature that examine the role of coracoacromial arch anatomy in the pathogenesis of glenohumeral instability. Previous reports found an association between posterior acromial coverage (PAC) and posterior instability. We hypothesize that coracoacromial arch anatomy is related to anterior shoulder instability.

Methods: In this retrospective cohort study, 50 patients with unidirectional anterior shoulder instability were matched to a control group of 50 glenohumeral arthritis patients without any history of shoulder instability. Radiographic measurements of the coracoacromial arch anatomy were made: shoulder arch angle, scapular Y angle, anterior coracoid tilt (ACT), posterior acromial tilt, anterior acromial coverage angle, PAC angle, coracoid height, posterior acromial height, and critical shoulder angle were determined using standard lateral scapular and anteroposterior radiographs.

Results: Logistic regression analyses found a significant association between the presence of anterior instability and flatter coracoacromial arch angles (mean, 124.1°) vs. the arthritis control group (mean, 120.6°) (odds ratios [OR] = 1.113; 95% confidence interval [CI] = 1.039-1.191; $P = .002$). There was a significant association between anterior instability and ACT (OR = 1.144; 95% CI = 1.053-1.243; $P = .001$), whereas a negative association was found between anterior instability and PAC (OR = 0.909; 95% CI = 0.853-0.969; $P = .004$) and posterior acromial tilt (OR = 0.878; 95% CI = 0.773-0.998; $P = .046$). Lower critical shoulder angle values were associated with the arthritis group (28.2° vs. 33.9°) (OR = 1.555; 95% CI = 1.202-2.012; $P = .001$).

Conclusions: Shoulder coracoacromial arch morphology may play a role in the stability of the shoulder joint and development of recurrent anterior instability. Shoulders with a decreased shoulder arch angle, a less contained and flatter coracoacromial arch and larger ACT, were associated with anterior instability. This study identifies the shoulder coracoacromial arch angle and anterior coracoid tile angles as risk factors for anterior shoulder instability. Our findings suggest that measuring these angles may help orthopedic surgeons understand the risk of anterior instability and analyze risk factors to improve clinical decision making.

Glenohumeral instability affects approximately 2% of the general population.[7,18] There are numerous studies on the role of glenoid and humeral bone loss in recurrent instability. Few studies in the literature examine the role of coracoacromial arch anatomy in the pathogenesis of glenohumeral instability. Acromial morphology previously has been implicated in subacromial impingement and rotator cuff degeneration.[2–4,6,8,15,16] More recent studies of acromial morphology have shown an association between a horizontally oriented acromial roof and development of both glenohumeral osteoarthritis[5] and posterior instability.[14] The authors suggested that a flat acromial roof provides reduced posterior glenoid coverage, which contributes to posterior subluxation of the humeral head and subsequent posterior glenoid wear. Little has been described about the sagittal coracoacromial arch anatomy and its role in shoulder anterior instability. Currently, there are no studies that measure the coracoacromial shoulder arch angle (SAA) and

Columbia University institutional review board approved this study (protocol # AAAS7452).

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assess the role of its anatomy in the pathogenesis of anterior glenohumeral instability.

Shoulders with a flatter roof of the coracoacromial arch likely have less overall containment of the humeral head in the sagittal plane. We hypothesize that coracoacromial arch anatomy is related to anterior shoulder instability. The aim of this retrospective study was to use radiographic measurements and clinical information to identify specific anatomical risk factors for the development of recurrent shoulder instability and correlation with severity of anterior instability.

Materials and methods

Study design

With institutional review board approval, we performed a retrospective analysis of a consecutive series of 50 shoulders treated with arthroscopic stabilization for recurrent anterior shoulder instability between January 2015 and December 2019. Patients in the instability group were clinically evaluated and had satisfactory shoulder radiographs, including standard true anteroposterior and lateral scapula views. Patients in the glenohumeral arthritis control group were included in the study if they obtained the same series of shoulder radiographs and had never had traumatic injury, shoulder surgery, or a shoulder dislocation. Patients were excluded from either group if they had any prior history of shoulder surgery. Patients were excluded from the anterior instability cohort if they had previous arthroscopic labral repair, coracoid transfer, multidirectional instability, evidence of a collagen disorder, chronic dislocation, glenoid fracture, glenoid dysplasia, or significant bone loss on the glenoid >20% or humerus with an off-track Hill-Sachs lesion. Likewise, patients were excluded from the osteoarthritis control cohort if they had a rotator cuff tear, Hamada grade 3 or above radiographic findings, and inflammatory arthritis with severe medialization of the glenoid joint line.

Clinical evaluation

Patient records from the institutional patient database at an academic medical center were retrospectively evaluated, and preoperative clinical scores and radiographs were recorded and analyzed. Demographic information including age, sex, diagnosis, concomitant conditions or injuries, sports and level of competition, and contact and noncontact sports was collected. In addition, patients were clinically evaluated at the initial visit and latest follow-up visit for shoulder range of motion (ROM), shoulder hyperlaxity, visual analog scale (VAS) pain, additional dislocations or instability episodes, surgical treatment, failed surgery or revision surgery, and if a patient was treated surgically, and other surgical complications. Shoulder instability severity was evaluated to correlate with anatomic measurements based on number of dislocations, need for surgical treatment, and the instability severity index (ISI) score, originally devised by Balg et al.[1]

Radiographic evaluation

Shoulder radiographs of patients with unidirectional anterior shoulder instability or glenohumeral osteoarthritis were used to quantitatively measure and analyze the anatomy of the shoulder coracoacromial arch. All radiographic measurements were independently recorded by 3 blinded fellowship-trained shoulder surgeons. Radiographic measurements were made using the institutional PACS system (Philips Intellispace Enterprise Edition; Philips Healthcare, Cambridge, MA, USA). The quality of each radiograph also assessed for inclusion for measurement including

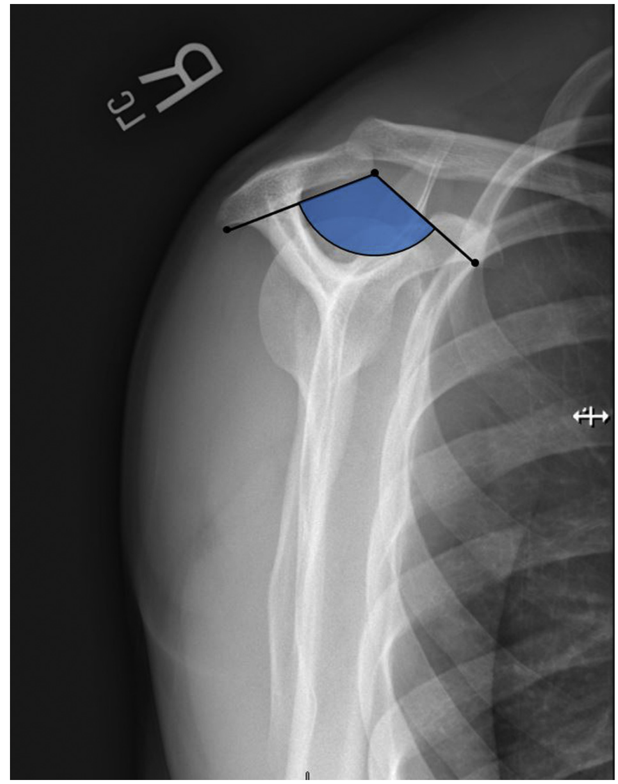

Figure 1 Measurement of the shoulder arch angle involves the angle formed by connecting 3 points: the posterior-inferior corner of the acromion, the most anterior-inferior corner of the acromion, and the most inferior edge of the coracoid.

the proper rotation on the true lateral radiographs so that the scapular spine and coracoid process appeared to form a symmetric Y-shape. Radiographs were disqualified if the bony landmarks for radiographic measurement were distorted by malrotation or the acromion or coracoid was poorly visualized.

Nine radiographic measurements of the coracoacromial arch anatomy were made using the PACS system and recorded for analysis (Figs. 1-9). The measurement of the coracoacromial arch was made on the lateral radiograph by connecting 3 points: the posterior-inferior corner of the acromion, the most anterior-inferior corner of the acromion, and the most inferior edge of the coracoid (Fig. 1). We termed this angle the SAA. Secondly, we recorded an angle formed by the columns of bone of the scapular spine and the coracoid on the lateral radiograph. This angle, the Scapular Y, was subtended by the columns of bone of the coracoid and the scapular spine meeting in the center of the glenoid (Fig. 2). The measurement of the posterior acromial anatomy was made using the posterior acromial coverage (PAC) angle (Fig. 3) and the posterior acromial tilt (PAT) (Fig. 4). The anterior coracoid tilt (ACT) angle (Fig. 5) is formed by a vertical line through the center of the glenoid and scapular body and the anterior undersurface of the coracoid and was measured by subtracting the PAT from the SAA. Likewise, the amount of anterior coverage of acromion on the lateral radiograph was measured using the anterior acromial coverage (AAC) angle (Fig. 6). By convention, positive angles reflected the acromion edge that projected anteriorly to the center of the glenoid. If the acromion edge was posterior to the center of the glenoid in the anterior-posterior direction, then this angle was recorded as negative. The heights of the inferior edge of the coracoid and the posterior inferior edge of the acromion were measured from the center of the glenoid and recorded as the coracoid height (CH) (Fig. 7) and the posterior acromial height (PAH) (Fig. 8), respectively. Because of nonstandardized scaling of radiographs,

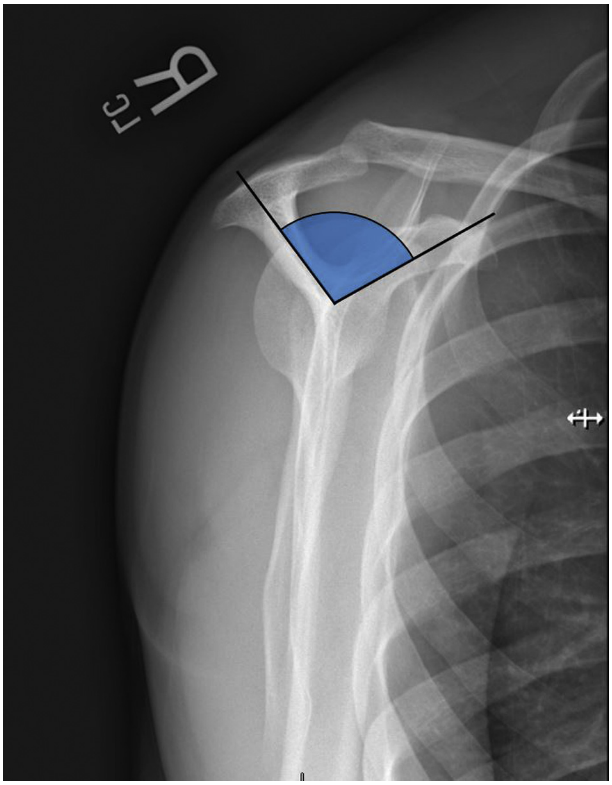

Figure 2 Measurement of the scapular Y angle involves the angle formed by the columns of bone of the scapular spine and the coracoid on the lateral radiograph.

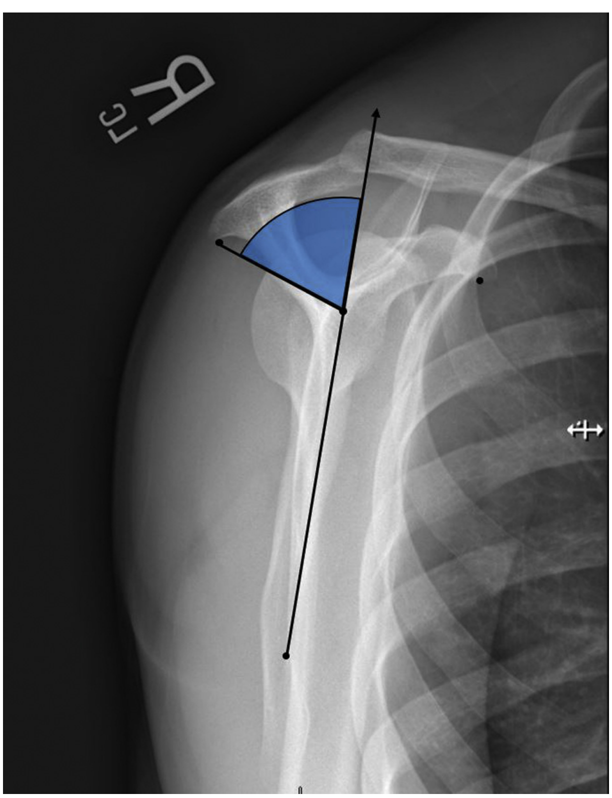

Figure 3 Measurement of the posterior acromial coverage angle involves the angle between the reference line and a line drawn from the most posterior point of the inferior aspect of the acromion to the intersection of the columns of the scapular spine and the coracoid.

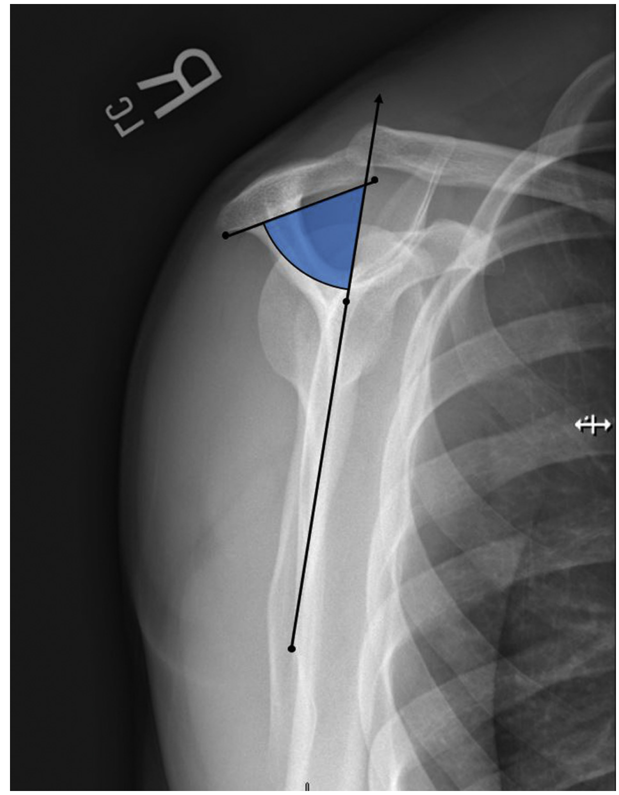

Figure 4 Measurement of the posterior acromial tilt involves the angle between the reference line and a line connecting the most posterior point of the inferior aspect of the acromion (posterior intersection of the inferior and superior sclerotic lines) to the most anterior point of the inferior aspect of the acromion (anterior intersection of the inferior and superior sclerotic lines).

the CH to PAH ratio was calculated, which represents the relationship between the CH and the PAH. Finally, the critical shoulder angle (CSA) was measured on standard true anteroposterior radiographs of the shoulder (Fig. 9).

Patient characteristics

In total, there were 50 anterior shoulder instability patients with a mean age at the time of initial evaluation of 22.4 years (±5.6 years), with ages ranging from 15 to 34 years (Table I). The control group included 50 glenohumeral arthritis patients with a mean age at the time of obtaining initial radiographs of 67.4 years (±7.0 years), with ages ranging from 53 to 85 years (Table I). There were a total of 85 males and 15 females in the study, with 44 males and 6 females in the instability group and 41 males and 9 females in the control group (Table I). Within the instability group, patients had an average of 3.5 dislocations (standard deviation [SD], 4.7) at the time of initial evaluation (Table I). All of the instability patients required surgical treatment of the affected shoulder, and the average ISI score was 3.7 (SD, 2.5) (Table I).

Statistical analysis

An a priori power analysis revealed that for a significance level of .05 (type I error), a sample size of 50 patients in each group would be sufficient to power the analysis at 80% and to determine significant differences in coracoacromial arch morphology angle (SAA). Categorical variables were reported as frequencies, and continuous variables were reported using means and SDs. χ^2 testing was used to analyze

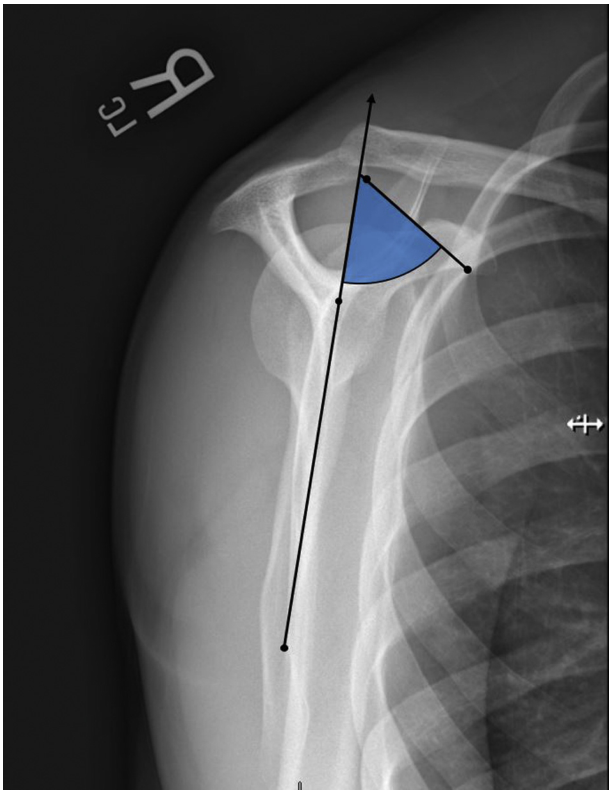

Figure 5 Measurement of the anterior coracoid tilt angle is formed by a vertical line through the center of the glenoid and scapular body and the anterior undersurface of the coracoid.

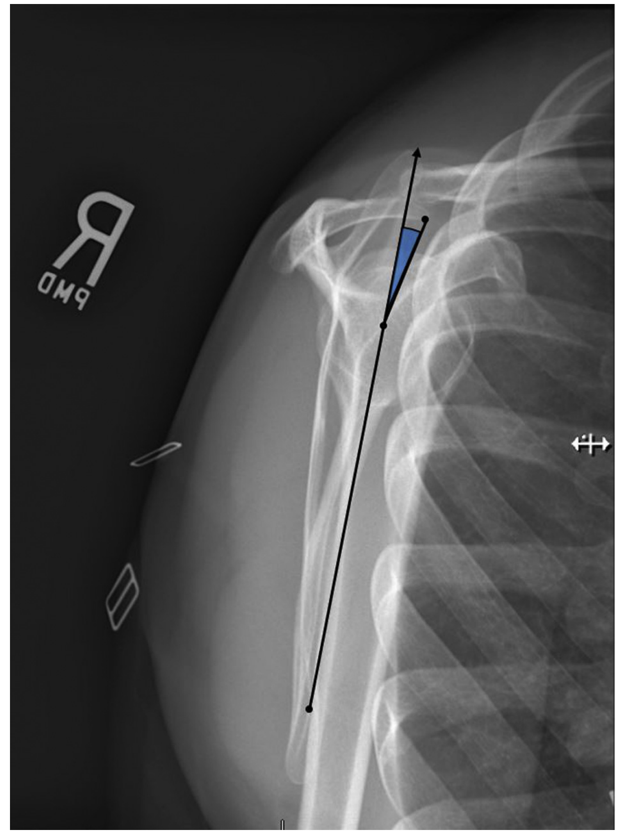

Figure 6 Measurement of the anterior acromial coverage angle involves the angle between the reference line and a line drawn from the most anterior point of the inferior aspect of the acromion to the intersection of the columns of the scapular spine and the coracoid.

relationships between categorical variables. Continuous data were assessed for normality using the Shapiro-Wilk W test and were compared using the unpaired *t*-test (comparison between the instability group and control group). Within the instability group, multiple linear regression analyses were conducted with demographic and patient-specific covariates (age, sex, sport played, number of dislocations, reduction method, instability direction, shoulder ROM, and visual analog scale pain score) and anatomic measurements (SAA, scapular Y angle, ACT, PAT, AAC, PAC, CH/PAH, CSA) as the independent variables and number of dislocations and shoulder instability severity grade as the dependent variables. After factoring for covariates in both groups and accounting for matched variables (including sex and concomitant conditions), binary logistic regression analyses were conducted using odds ratios (ORs) to determine significant associations between measured anatomic factors and the presence of instability (binary outcome). Separate regression models with anatomic measurements including the ACT and PAT instead of the SAA were also used to assess the association between the outcome variables and anterior and posterior bony coverage of the SAA. A multirater kappa statistic was used to measure interobserver reliability, with a value of 1 indicating perfect reliability.[13] All statistically significant parameters were calculated using standard x-ray measurements in the appropriate radiographic view for each patient. Statistical significance was set at $P < .05$. All analyses were performed in Stata (version 16.1; Stata Corporation, College Station, TX, USA).

Results

Interobserver reliability

Interobserver reliability was measured using Cohen's kappa values that were within the "strong" (0.80-0.89) to "almost perfect" (0.90 and above) agreement range of interpretation.[13] Kappa values were calculated for the SAA ($r = 0.86$; 95% confidence interval [CI] = 0.76-0.96), scapular Y angle ($r = 0.82$; 95% CI = 0.75-0.89), AAC ($r = 0.86$; 95% CI = 0.75-0.97), PAC ($r = 0.84$; 95% CI = 0.78-0.90), PAT ($r = 0.89$; 95% CI = 0.80-0.98), CH/PAH ratio ($r = 0.95$; 95% CI = 0.91-0.99), and CSA ($r = 0.84$; 95% CI = 0.72-0.96) (Table II). ACT values were calculated from the measured SAA and PAT values.

Comparison of radiographically measured anatomic factors

The unpaired *t*-test confirmed that compared with patients in the control group, instability cohort patients had significantly larger mean SAA (124.1° vs. 120.6°; $P = .044$) corresponding to a flatter coracoacromial arch roof (Table III). Similarly, instability patients had a larger mean ACT compared with the control group (59.6° vs. 53.3°; $P = .010$), although PAT was not significantly different between the groups. PAC (57.6° vs. 69.9°; $P < .001$) was found to be significantly lower in the instability cohort vs. the arthritis group. Instability patients had a significantly larger CSA (33.9° vs. 28.4°; $P < .001$) (Table III). There were no statistically significant differences in the other measured anatomic factors between both groups (Table III).

Factors associated with the presence of instability

Logistic regression analyses found a significant association between the presence of instability and 2 of the measured anatomic factors: SAA (OR = 1.113; 95% CI = 1.039-1.191; $P = .002$) and CSA (OR = 1.555; 95% CI = 1.202-2.012; $P = .001$) (Table IV). There was

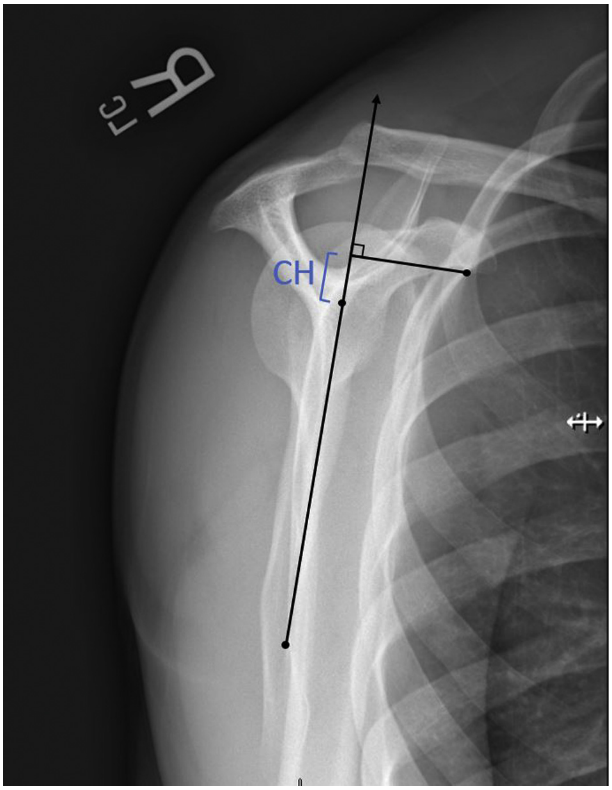

Figure 7 Measurement of the coracoid height (CH) involves the distance from the inferior edge of the coracoid from the center of the glenoid.

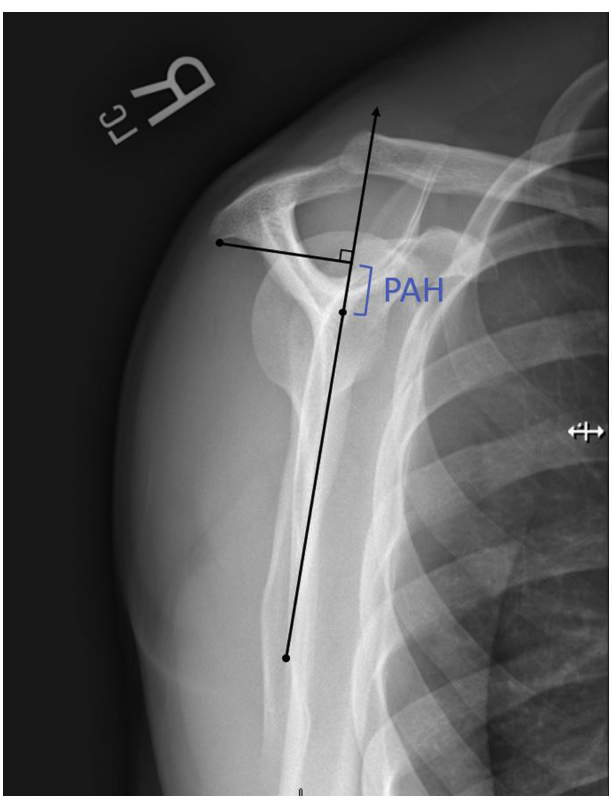

Figure 8 Measurement of the posterior acromial height (PAH) involves the distance from the posterior inferior edge of the acromion from the center of the glenoid.

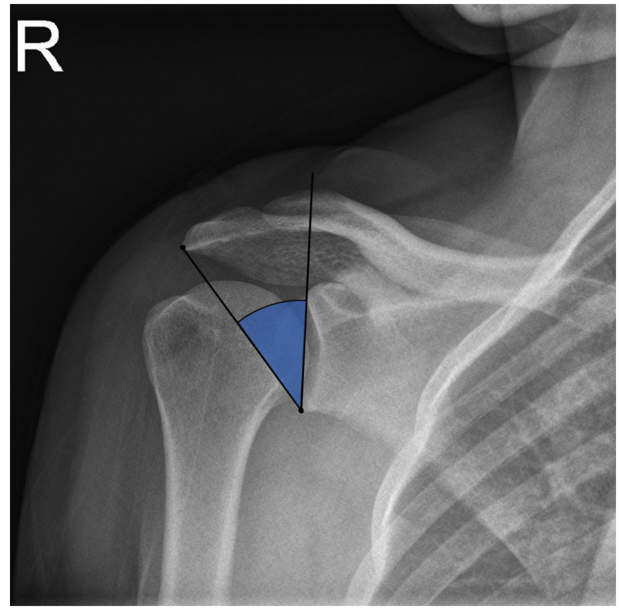

Figure 9 Measurement of the critical shoulder angle involves the angle between the line parallel to the glenoid and the line from the inferior most aspect of the glenoid to the lateral most edge of the acromion.

also a significant association between a larger ACT and the presence of instability (OR = 1.144; 95% CI = 1.053-1.243; P = .001) (Table IV). However, there was a significant negative association between instability and PAC (OR = 0.909; 95% CI = 0.853-0.969; P = .004) and PAT (OR = 0.878; 95% CI = 0.773-0.998; P = .046) (Table IV). There were no significant OR associations between any of the other variables and incidence of instability. The Hosmer-Lemeshow goodness-of-fit test produced a nonsignificant P value of .901, indicating that the logistic regression model fits the data well.

Factors associated with severity of instability

No significant association was found between number of dislocations and any of the measured anatomic measurements or patient covariates, including patient age, level of sport competition, dislocation method, and shoulder ROM (Table V). There was no significant association between any anatomic measurement and ISI as a measure of shoulder severity. Multivariate regression analyses within the instability cohort determined that age had a significant negative association with ISI score (regression coefficient, −0.242; 95% CI = −0.317 to −0.167; $P < .001$), whereas level of competition had a significant positive association with ISI (regression coefficient, 0.815; 95% CI = 0.126-1.503; P = .022) (Table VI).

Discussion

To our knowledge, this is the first study to measure the coracoacromial arch anatomy of patients with anterior shoulder instability and evaluate the relationship between shoulder arch morphology and the presence and severity of recurrent anterior instability. We found that patients with anterior instability tend to have a significantly more obtuse coracoacromial arch (mean SAA, 124.1° vs. 120.6°), with a flatter roof and less contained humeral head compared with noninstability osteoarthritis patients. Similarly, less anterior coracoid tilt (larger ACT) was also found to be associated with anterior instability. PAC and PAT were significant protective factors against the incidence of anterior instability. Lower values of the CSA were found to be strongly associated with

Table I
Patient demographics of the instability and control groups

	Instability group (n = 50)	Control group (n = 50)
Average age (yr)	22.4 ± 5.6	67.4 ± 7.0
Males/females (n)	44/6	41/9
Average dislocations at initial visit (n)	3.5 ± 4.7	–
Need for surgical treatment, n (%)	50 (100)	–
Instability severity index score	3.7 ± 2.5	–

Table II
Interobserver reliability of radiographic anatomic measurements

Measured anatomic factors	Cohen's value (*r*)	95% confidence interval	
Shoulder arch angle (°)	0.86	0.76	0.96
Anterior acromial coverage angle (°)	0.86	0.75	0.97
Posterior acromial coverage (°)	0.84	0.78	0.90
Posterior acromial tilt (°)	0.89	0.80	0.98
Scapular Y angle (°)	0.82	0.75	0.89
Critical shoulder angle (°)	0.84	0.72	0.96
Coracoid height/posterior acromial height ratio	0.95	0.91	0.99

Biomechanical studies suggested that elevated CSA may increase the lateral shear force of the deltoid and decrease the compressive force of the rotator cuff, leading to increased wear on the supraspinatus tendon.[10] CSA values greater than 35° were associated with rotator cuff tearing, whereas values less than 28° were associated with osteoarthritis. Likewise, multiple studies have associated the CSA and rates of retearing after rotator cuff repair.[9,11] The CSA has even been shown to be an accurate and reproducible measurement that may predict glenoid component loosening after total shoulder arthroplasty.[17]

However, there remains a paucity of studies that examine the role of acromial anatomy in the pathogenesis of shoulder instability. To our knowledge, there are no studies that measure the shoulder coracoacromial arch anatomy, including the SAA, and evaluate its association with anterior instability. Jacxsens et al analyzed coracoacromial and glenoid anatomy in patients with recurrent traumatic anterior shoulder instability and compared with a control group of cadaveric shoulders.[12] They found significant anatomical differences between both groups, with instability shoulders generally having a shorter coracoid, more vertical acromion, and a glenoid with flatter anterior-posterior radius of curvature. They also concluded that soft tissue stabilization procedures do not address pathologic anatomy and may even contribute to recurrent instability. Previous investigations of acromial anatomy

Table III
Comparison of measured anatomic factors between the instability and control groups

Variable	Mean ± standard deviation		Absolute value of difference	*P* value
	Instability (N = 50)	Arthritis (N = 50)		
Shoulder arch angle (°)	124.1 ± 10.1	120.6 ± 7.2	3.5	**.044**
Anterior coracoid tilt (°)	59.6 ± 13.8	53.3 ± 12.0	6.1	**.010**
Anterior acromial coverage angle (°)	3.0 ± 7.1	4.4 ± 8.8	1.4	.361
Posterior acromial coverage (°)	57.6 ± 13.0	69.9 ± 10.6	12.3	**<.001**
Posterior acromial tilt (°)	64.5 ± 8.6	67.3 ± 8.7	2.8	.113
Scapular Y angle (°)	114.6 ± 14.6	113.5 ± 13.4	1.1	.696
Critical shoulder angle (°)	33.9 ± 4.8	28.4 ± 3.7	5.5	**<.001**
Coracoid height/posterior acromial height ratio	0.84 ± 0.99	0.56 ± 1.13	0.3	.197

$P < .05$ are indicated in bold.

Table IV
Factors associated with incidence of instability (odds ratio) on logistic regression analysis

Variable	Odds ratio	*P* value	95% confidence interval	
Measured anatomic factors				
Shoulder arch angle (°)	1.113	**.002**	1.039	1.191
Anterior coracoid tilt (°)	1.144	**.001**	1.053	1.243
Anterior acromial coverage angle (°)	0.958	.282	0.885	1.036
Posterior acromial coverage (°)	0.909	**.004**	0.853	0.969
Posterior acromial tilt (°)	0.878	**.046**	0.773	0.998
Scapular Y angle (°)	1.026	.620	0.927	1.135
Critical shoulder angle (°)	1.496	**.002**	1.162	1.926
Coracoid height/posterior acromial height ratio	1.806	.134	0.834	3.913
Covariates				
Female sex	0.163	.103	0.018	1.440

$P < .05$ are indicated in bold.

the incidence of glenohumeral arthritis as have been reported by others.[10]

Acromial anatomy and its influence on shoulder pathology have long been investigated by orthopedic researchers. As classically described by Neer[15] and Bigliani,[11] the acromion has been associated with subacromial impingement and extrinsic rotator cuff degeneration.[2–4,6,8,15,16] In recent years, there has been a focus on the lateral projection of the acromion, measured by the CSA. in relation to glenohumeral stability were also performed by Gerber et al.[5,13] Studies have found that a horizontally oriented acromial roof is associated with increased rates of posterior wear and eccentric osteoarthritis.[5] A later study by the same group demonstrated an association between PAH and posterior instability vs. an anterior instability control group.[13] They hypothesized that a flatter roof with less PAH provided less mechanical block of the humeral head in the posterior direction and predisposed patients to

Table V
Factors associated with total number of dislocations on multivariate regression analysis

Variable	Regression coefficient	*P* value	95% confidence interval	
Measured anatomic factors				
Shoulder arch angle (°)	0.021	.884	−0.265	0.307
Anterior coracoid tilt (°)	−0.008	.941	−0.232	0.215
Anterior acromial coverage angle (°)	0.130	.238	−0.090	0.350
Posterior acromial coverage (°)	−0.004	.940	−0.124	0.115
Posterior acromial tilt (°)	0.004	.979	−0.264	0.271
Scapular Y angle (°)	−0.007	.955	−0.259	0.245
Critical shoulder angle (°)	−0.106	.511	−0.431	0.219
Coracoid height/posterior acromial height ratio	0.170	.835	−1.476	1.815
Covariates				
Age	−0.179	.206	−0.461	0.103
Level of competition	0.265	.753	−1.434	1.965
Reduction method	1.550	.108	−0.354	3.453
Average range of motion	15.432	.077	−1.778	32.642
VAS pain	0.581	.236	−0.396	1.557

VAS, visual analog scale.

Table VI
Factors associated with instability severity index on multivariate regression analysis

Variable	Regression coefficient	*P* value	95% confidence interval	
Measured anatomic factors				
Shoulder arch angle (°)	0.052	.125	−0.015	0.119
Anterior coracoid tilt (°)	0.037	.221	−0.023	0.098
Anterior acromial coverage angle (°)	0.006	.828	−0.053	0.066
Posterior acromial coverage (°)	0.001	.970	−0.032	0.033
Posterior acromial tilt (°)	−0.024	.514	−0.096	0.049
Scapular Y angle (°)	0.059	.089	−0.009	0.127
Critical shoulder angle (°)	0.027	.536	−0.061	0.115
Coracoid height/posterior acromial height ratio	0.097	.662	−0.348	0.542
Covariates				
Age	−0.240	**<.001**	−0.316	−0.163
Level of competition	1.253	**<.001**	0.793	1.713
Reduction method	0.242	.347	−0.273	0.757
Average range of motion	2.460	.291	−2.197	7.117
VAS pain	0.024	.854	−0.240	0.289

$P < .05$ are indicated in bold.
VAS, visual analog scale.

posterior instability. But no studies have examined the role of the entire coracoacromial arch in anterior instability.

This study confirms our hypothesis that a flatter coracoacromial arch measured by a larger SAA was associated with anterior shoulder instability. In addition, less anterior tilt of the coracoid, measured by a larger ACT angle, was also associated with anterior instability. Although the concept of PAC and posterior instability was previously described by Gerber et al,[13] this study is the first to examine the role of the entire coracoacromial arch on anterior instability. It is important to note that we reconfirmed Gerber's findings in our series and showed that PAC and PAH (PAT) were associated with decreased rates of anterior instability. The posterior acromial anatomy is an important component of the coracoacromial arch, and the PAT angle composes the posterior leg of the angle. In summation, these measurements all contribute to the SAA and the bony containment of the humeral head in the sagittal plane.

The severity of pathology among our anterior instability patients was significant as patients average 3.5 dislocations before surgery and 100% underwent arthroscopic stabilization. Four patients in the cohort had remplissage procedures despite an on-track lesion. There were no Latarjet procedures or surgeries with glenoid bone grafting as patients with significant glenoid bone loss >20% were excluded from the study. Although our research does not identify a causal relationship between shoulder arch anatomy and the development or severity of recurrent anterior shoulder instability, it strongly supports a significant association. Additional biomechanical analysis and modeling may assist in demonstrating how morphological factors such as increased SAA and less contained coracoacromial arch influence shoulder instability.

In our conception of the complex interrelationship of static and dynamic constraints of shoulder instability, the SAA may provide a measure of the true bony constraint to anterior inferior instability, or more likely it is a surrogate marker of the risk of instability and laxity. Thus, a flatter SAA may be associated with adaptive changes during development or familial characteristics that are associated with capsular laxity and hypermobility of the shoulder joint. In this theory, a shoulder with more bony coracoacromial constraint may have decreased laxity associated with an improved ACT coverage, steeper PAT, and greater PAC, explaining our findings of associations of PAT and PAC with reduced anterior instability.

The strengths of our study include the clinical applicability of our simple radiographic measurement method in routine orthopedic practice. Our study was adequately powered and incorporated the use of a linear regression model to understand the predictive relationship between shoulder arch anatomy and the shoulder instability index, which provides statistical insight beyond correlation alone. The limitations of our study include the selection of a non–age-matched cohort of glenohumeral osteoarthritis patients, with an average age of 67.4 years, compared with 22.4 years in the anterior instability group, due to an insufficient number of radiographs of younger noninstability patients to form a control group. Although the osteoarthritis patients did not have the history of instability or trauma, age may be a confounding variable in this study as the steeper coracoacromial arches in the arthritis group may be the result of age-related changes. We also acknowledge the inherent challenges and potential inaccuracies of measuring 3-dimensional anatomy on 2-dimensional imaging. Perhaps different than posterior instability, all of our anterior instability patients had a traumatic event leading to a dislocation.

Conclusions

Shoulder coracoacromial arch morphology plays a significant role in the stability of the shoulder joint and development of recurrent anterior instability. This study identifies the SAA and the ACT as risk factors for anterior instability, as patients with a less contained coracoacromial arch were associated with anterior instability requiring arthroscopic stabilization. Greater PAC and PAT were also associated with reduced anterior shoulder instability contributing to the concept that the entire arch, both anteriorly and posteriorly, is important for stability. This simple radiographic measurement method can be employed in routine orthopedic care to analyze risk of shoulder instability and to assist risk factor analysis to improve clinical decision making.

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