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Original Research Article

Osteometric Assessment of Coracoid Process of Scapula-Clinical Implications

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Abstract

The coracoid process is a bony projection arising from the antero-lateral aspect of the scapula. The variation in the height and length of the coracoid process are responsible for altered size and shape of the space between the coracoacromial arch and the rotator cuff. The study was conducted on sixty-four dry adult human scapulae of unknown age and sex with a view to elucidate the morphological and osteometric details. The length of coracoid process on right side was 41.01±3.55 mm and it was found to be 40.88±3.83 mm on left sided. The breadth of coracoid process was observed as 13.93±1.13 mm and 13.25±1.26 mm on right and left side respectively and the difference between the two sides was statistically significant ($p=0.026$). Thickness of the coracoid process was 8.59±1.32 mm and 8.01±1.16 mm in right and left sided scapulae. The acromiocoracoid distance was found to be 38.48±4.03 mm on right side and 35.51±3.83 mm on left sided scapulae and the difference between to the two sides showed high statistically significance ($p=0.004$). Mean coracoglenoid distance was noted 26.23±3.05 mm and 24.94±2.75 mm on right and left sided scapulae respectively. Values of the thickness of coracoid process recorded in the present study are at appreciable variance with the result of previous study. The coracoid process constitutes an important component of the scapular glenoid construct and is involved in many surgical interventions on the glenohumeral joint. Comprehension of standard morphometric details of the coracoid process is vital in traumatic cases, surgical interventions and replacement surgeries in the shoulder region.

Keywords: Coracoid, process, scapula, osteometric, clinical

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Introduction

Human scapula is a flat triangular shaped bone placed on posterolateral aspect of thoracic cage forming back of the shoulder girdle. The human scapula is formed of two components phylogenetically that have fused together: the (dorsal) scapula proper and the (ventral) coracoid (1). Scapula plays a significant function in the movements of shoulder girdle (2).

The coracoid process is a bony projection arising from the antero-lateral aspect of the scapula. The morphology of the coracoid is extremely variable (3). The size and shape of the space between the coracoacromial arch and the rotator cuff is dependent upon the morphometric measurements of the coracoid process. The coracoid process also forms an important part of the scapular glenoid assembly and is involved in many surgical procedures on the glenohumeral joint. A meticulous morphometricstudy will definitely prove helpful in surgical procedures such as hardware fixation, drill hole placement and prosthetic positioning (4).

Therefore, alterations in the morphology of the coracoid process should be compulsorily taken into consideration prior to planning any surgical interventions in this region (3). The etiology of subcoracoid impingement was discussed in a previous study and it was found that few patients had idiopathic impingement, which appeared to be caused by a long coracoid process projecting more laterally than normal (5). Moreover, anatomical considerations are vital in understanding specific conditions such as glenohumeral dislocation and rotator cuff injuries (6).

The scapula may be involved in fractures, dislocation, arthritis, tumours and developmental anomalies.The surgical procedures involving scapula include arthroplasty and arthrodesis of glenohumeral joint, acromioplasty for rotator cuff disorders and scapulothoracic tenodesis for winging (6). Indications for shoulder arthroplasty currently include severe proximal humeral fractures, primary glenohumeral osteoarthritis, post traumatic arthritis, shoulder girdle tumors, osteonecrosis and failed shoulder arthroplasty (7).

The detailed anatomical knowledge of the scapula is relevant for surgical procedures involving this bone including arthroscopic operations, hardware fixation, drill hole placement and prosthetic positioning (4).

The proposed study envisages to carry out the morphological and osteometric assessment of human coracoid process in Indian population since most of the published work on scapula refers to Western population and there is scarcity of comprehensive studies on the coracoid process of the Human scapula.

Limitation of the study according to the authors may be the fact that the bones were retrieved from anatomical specimen in the department and therefore their age is unknown. Moreover, in future this study may be combined with radiological investigation to corroborate the findings.

Figure 1: Photograph showing Dimensions of coracoid process (j: Length of coracoid process, k: Breadth of coracoid process)

Figure 2: Photograph showing thickness of coracoid process (l: Thickness of coracoid process)

Materials and Methods

The study was conducted in the Department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi.

The study was conducted on sixty-four dry adult human scapulae of unknown age and sex with a view to elucidate the morphological and osteometric details.

Inclusion criteria was Adult Human Scapulae and Bones with normal gross morphology

Exclusion criteria were Bones showing gross deformity or defect, Broken scapulae and Scapulae showing degenerative changes.

All the scapulae were carefully studied and the observations were noted using the following parameters: Length of the coracoid process was measured as the distance between base to the tip of the coracoid process (Fig. 1), Breadth of the coracoid process was measured as the maximum distance from lateral border to the medial border of the coracoid process (Fig. 1), Thickness of the coracoid process was observed at mid point of the coracoid process taken anteroposteriorly (Fig. 2), Acromiocoracoid distance**:** This distance was measured between tip of the acromion process and tip of the coracoid process (Fig. 3), Coracoglenoid distance**:** It was measured as minimum distance from tip of the coracoid process to the anterior margin of the glenoid cavity (Fig. 4).

The osteometric evaluation of scapula was carried out by using Digital Vernier Calliper (Fig. 5) sensitive to

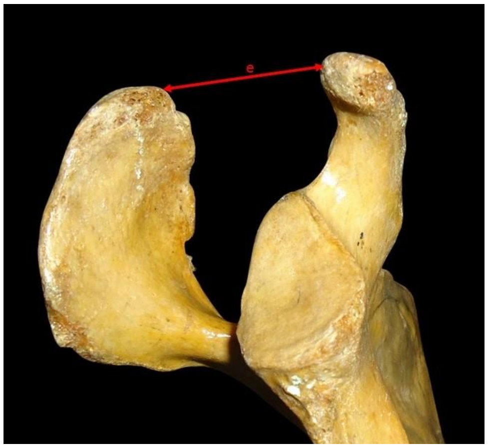

Figure 3: Photograph showing Acromio-coracoid distance (e: Acromiocoracoid distance)

Figure 4: Photograph showing Coraco-glenoid distance (g: Coracoglenoid distance)

0.1 mm. The observations were carefully recorded and discussed in the light of previous literature.

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected, then non parametric test was used.

Statistical tests were applied as follows-
1. Quantitative variables were compared using Unpaired t-test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.
2. Qualitative variables were correlated using Chi-Square test /Fisher's exact test.

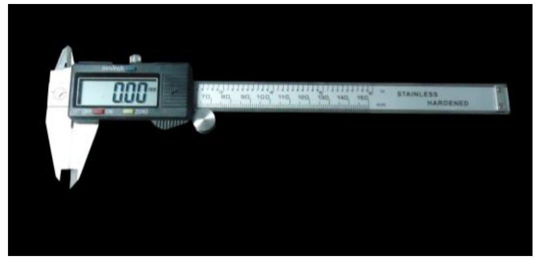

Figure 5: Digital Vernier Calliper

3. Pearson correlation coefficient/Spearman rank correlation coefficient was used to assess the association of various quantitative parameters.

A p value of <0.05 was considered statistically significant.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

The present investigation focussed on the morphology and osteometric details of sixty-four coracoid processes of human scapulae. The study was conducted on right and left sided scapulae. The observations were categorized to compare the right and left sided parameters.

Mean length of coracoid process on right side was 41.01±3.55 mm and it was found to be 40.88±3.83 mm on left sided scapulae with "p" value 0.889. Range of length of coracoid process was (32.72-48.90) and (30.82-46.93) on right and left side respectively. Thickness of the coracoid process was 8.59±1.32 mm and 8.01±1.16 mm in right and left sided scapulae. Range of thickness of coracoid process was (5.6-11.94) and (6.34-11.04) on right and left side

Table 1: Parameters of coracoid process

Parameters	**Mean±SD(mm) Range= Min.-Max.(mm)**		**p Value**
	Right(n=32)	**Left(n=32)**	
Length	41.01±3.5 (32.72-48.90)	40.88±3.83 (30.82-46.93)	0.889
Breadth	13.93±1.13 (11.72-16.18)	13.25±1.26 (10.52-15.41)	0.026*
Thickness	8.59±1.32 (5.6-11.94)	8.01±1.16 (6.34-11.04)	0.064

Table 2: Correlation of maximum length of coracoid process with other parameters

Parameter	Maximum scapular length	Vertical diameter of glenoid cavity	Maximum length of acromion process	Coracoglenoid distance
Maximum length of coracoid process	0.469	0.464	0.448	0.467
(p<0.0001)	p<0.0001	p<0.0001	p<0.0001	p<0.0001

respectively. Mean breadth of coracoid process was observed as 13.93±1.13 mm and 13.25±1.26 mm on right and left side respectively and the difference between the two sides was statistically significant (p=0.026). Range of breadth was (11.72-16.18) and (10.52-15.41) on right and left side respectively as shown in Table 1. Bar diagram 1 depicts the various dimensions of coracoid process in right and left sided scapulae.

Length of coracoid process was found to be significantly correlated (p<0.0001) with the coracoglenoid distance, maximum scapular length, maximum length of acromion process and vertical diameter of the glenoid cavity (Table 2).

Breadth of coracoid process showed correlation (p<0.0001) with transverse and vertical diameters of the glenoid cavity.

Thickness of coracoid process was found to be highly correlated (p<0.0001) with transverse diameter of the glenoid cavity.

Acromiocoracoid distance was measured from tip of acromion process to the tip of coracoid process. Mean acromiocoracoid distance was found to be 38.48±4.03mm on right side and 35.51±3.83mm on left sided scapulae and the difference between to the two sides showed high statistically significance (p= 0.004) as shown in Table 3. Bar diagram 2 depicts the comparison of acromiocoracoid distance in right and left sided scapulae.

Mean coracoglenoid distance was noted 26.23±3.05 mm and 24.94±2.75 mm on right and left sided scapulae respectively with "p" value 0.081. The range was 16.36-31.34 mm on right side and 19.72-30.53 mm on left side respectively as depicted in Table 4. Bar diagram 3 depicts the comparison of coracoglenoid distance in right and left sided scapulae. Coracoglenoid distance was found to be highly correlated (p<0.0001) with length of the coracoid process.

Discussion

The human scapula is a flat triangular bone situated posteriorly. The morphometric analysis of scapular dimensions provides pertinent information for various surgical procedures involving fixation of scapular fractures, resection and reconstruction of scapula tumour and reestablishment the stability of glenohumeral joint (8). The present study was conducted to evaluate the morphometric measurements of human scapula in dry bones to provide baseline data. The morphometric study was carried out highlighting the dimensions of the coracoid process of the scapula including the acromiocoracoid and coracoglenoid distances. The current study also attempted to explore any difference of data between the two sides (right and left). It is expected that the observations of present study will contribute as an anatomical reference for researchers and clinicians. The data pertaining to each parameter was compared to the findings of previous researchers. In many aspects, the observations of the present study correspond reasonably well with the data of earlier studies. However, the discrepancies could possibly be due to racial dissimilarities and regional variations.

Table 3: Parameters of coracoid process

Parameters	**Mean±SD(mm) Range= Min.-Max.(mm)**		**p Value**
	Right(n=32)	**Left(n=32)**	
Acromiocoracoid distance	38.48±4.03 (29.50-44.92)	35.51±3.83 (24.58-41.67)	0.004*

Table 4: Parameters of coracoid process

Parameters	**Mean±SD(mm) Range= Min.-Max.(mm)**		**p Value**
	Right(n=32)	**Left(n=32)**	
Coracoglenoid distance	26.23±3.05 (16.36-31.34)	24.94±2.75 (19.72-30.53)	0.081

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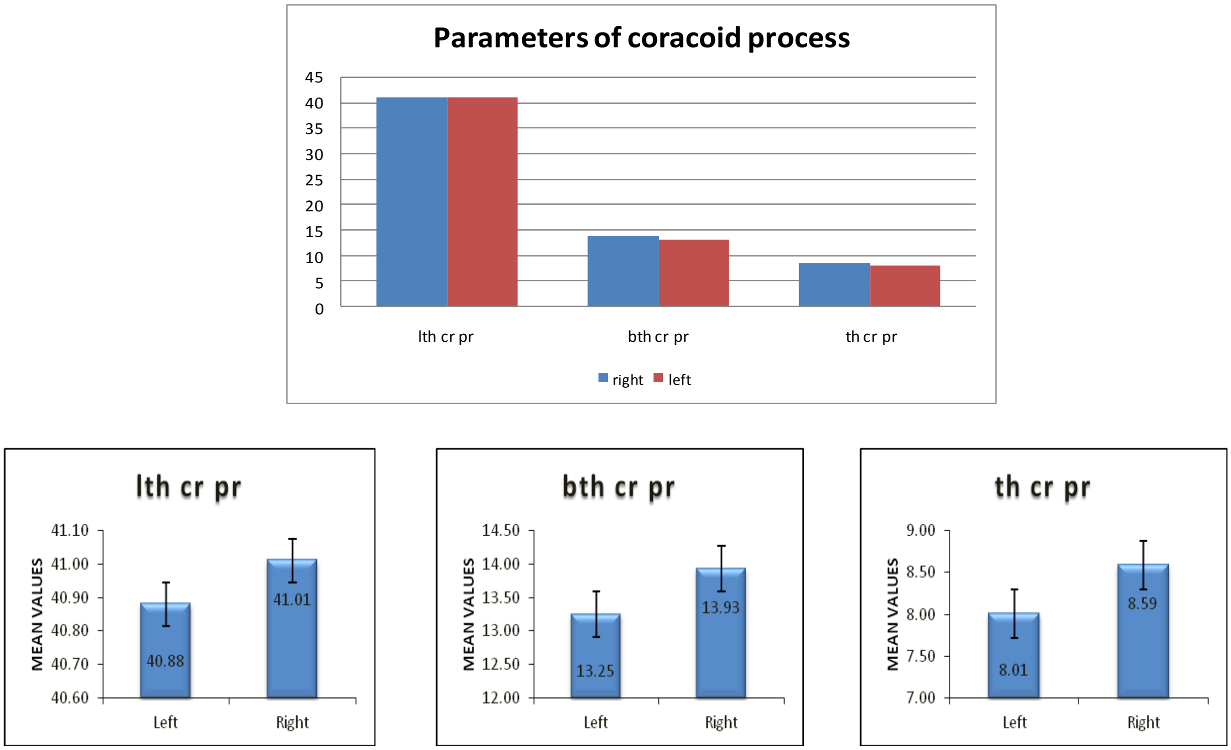
Table 5: Comparison of dimensions of the coracoid process in various studies

Studies	Year			Length	Breadth	Thickness
Gumina et al. (5)	1999	Both sides		38.15±3.97	-	7.19±1.04
Kavita et al (3)	2013	Right		40.9±3.6	-	7.3±1.1
		Left		41.1±4.3	-	7.4±1.1
Rajan et al.(4)	2014	Right		40.70	13.68	7.80
		Left		40.16	13.87	7.85
Kalra et al. (11)	2016	Both sides		40.4±4.4	14.1±2.3	8.5±1.7
Lingamdenne et al. (15)	2016	Both sides		39.04±4.16	-	-
		Indians	Right	39.15±1.30	12.93±1.31	8.70±1.07
			Left	39.24±1.57	13.12±1.42	8.46±1.07
		Chinese	Right	43.19±1.44	13.59±1.09	11.67±0.72
Fathi et al. (9)	2017		Left	43.44±1.69	13.68±1.13	11.25±0.43
		Myanmerese	Right	42.42±0.94	13.22±0.57	9.00±0.31
			Left	42.51±1.16	13.12±0.48	9.16±0.79
Present Study		Right		41.01±3.55	13.93±1.13	8.59±1.32
		Left		40.88±3.83	13.25±1.26	8.01±1.16

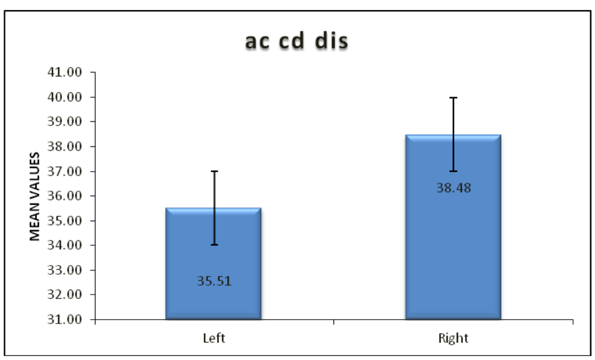
Table 6: Comparison of the acromiocoracoid (ACD) and coracoglenoid (CG) distances by various authors

Studies		ACD distance (mm)	CG distance (mm)
Gumina et al. (5)	Both sides	-	16.23
Schroeder et al. (6)	Both sides	-	50.7
Coskun et al. (12)	Both sides	17.8	-
Paraskevas et al. (16)	Both sides	28.1	-
Collipal et al. (17)	Right	39.76±5.2	-
	Left	39.55±5.4	-
Mansur et al. (18)	Right	39.03±6.20	-
	Left	31.83±3.66	-
Singh et al. (19)	Right	37.1±5.5	-
	Left	37.9±5.2	-
Kavita et al. (3)	Right	-	23.3±2.5
	Left		22.9±3.1
Rajan et al. (4)	Right	-	27.53
	Left	-	26.56
Musa et al. (13)	Both sides	15.48	-
El din et al. (20)	Right	31.10±3.55	-
	Left	31.58±3.09	-
Gosavi et al. (21)	Both sides	26.9	-
Gupta et al. (22)	Right	31.8±4.3	-
	Left	30.3±5.5	-
	Right	25.63±4.3	-
	Left	24.24±4.4	-
Naidoo et al. (23)	Male	25.93±4.3	-
	Female	23.50±4.1	-
	Black	24.90±4.4	-
	White	25.87±5.7	-
Lingamdenne et al. (15)	Both sides	31.85±4.4	-
Nweke et al. (24)	Both sides	40.02±6.9	-
Saha et al. (25)	Both sides	28.43±5.3	-
Present study	Right	38.48±4.03	26.23±3.05
	Left	35.51±3.83	24.94±2.75

Bar Diagram 1: Parameter of coracoids process



Bar Diagram 2: Acromiocoracoid distance



Bar Diagram 3: Coracoglenoid distance

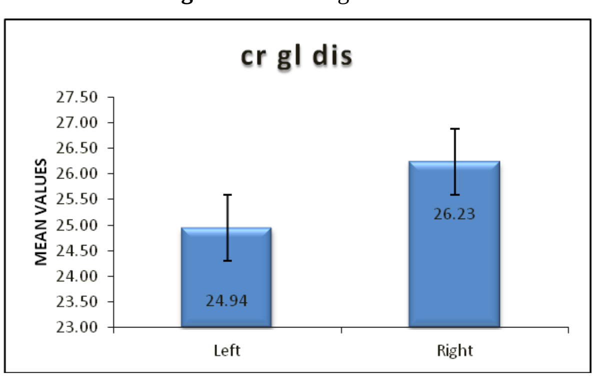


Table 5 depicts the parameters of the coracoid process in different populations in studies conducted by various authors. It is evident that the dimensions of the coracoid process in the present study show similarities with the earlier studies. However, the values of the thickness of coracoid process recorded in the present study are at appreciable variance with the result of the study done by Fathi et al. (9).

The coracoid process constitutes an important component of the scapular glenoid construct and is involved in many surgical interventions on the glenohumeral joint (10). Variations in the dimensions of coracoid process are of importance for Radiologists and Orthopaedics surgeons in diagnosis of various pathological conditions and for planning reparative procedures (11). Comprehension of standard morphometric details of the coracoid process is vital in traumatic cases, surgical interventions and replacement surgeries in the shoulder region (11). The values of acromiocoracoid distance recorded in the present study display significant variance from results of earlier studies (12,13). Further, much higher values of coracoglenoid distance was reported by Schroeder et al. (6). The exclusiveness of our study lies in the fact that all the three measurements viz. coracoacromial, coracoglenoid and acromioglenoid distances have been recorded whereas most of the earlier studies have focussed on one or two of these parameters. Accurately measured distances with reference palpable osseous landmarks is useful for portal placement while carrying out shoulder arthroscopy (6). Coracoacromial distance constitute a key factor for understanding etiology of shoulder pain (13). Narrower gap increases the risk for occurrence of rotator cuff rupture (14).The current study revealed differences in the various morphometric parameters of the coracoids process of scapula when compared to previous studies. This could possibly be explained on the basis of racial variations. An attempt has been made to provide a baseline data on morphological and osteometric details of coracoids process in Indian subjects. One of the salient highlights of the current investigation is the correlation between various osteometric parameters. High statistical significance observed in correlation between some osteometric parameters supports their suitability for application in predicting the dimensions of implants for shoulder arthroplasty. It is also expected that these results may prove beneficial in medicolegal investigation and may be utilized for scapular reconstruction as well.

The morphometric details of the coracoid process assume significance in surgical procedures such as hardware fixation, drill hole placement and prosthetic positioning (5). Congenital variation and minimal traumatic/Iatrogenic changes in this orientation can predisposed to subcoracoid dislocation (10). Variations pertaining to height and length of the coracoid process are believed to be responsible for alteration in the shape of the space between coracoacromial arch and rotator cuff (4).

Conclusion

Familiarity with osteometric details and morphological variations of human scapula is of great relevance for orthopaedic surgeons. Precise knowledge of the morphometric values of scapula and its components is crucial for achieving successful outcome of surgical procedures. Dimensional anatomy of scapula is of paramount significance for performing surgical procedures involving scapular fractures and glenohumeral joint. The results of the current study revealed a wide range of dimensions with regard to various scapular components. Some of the osteometric parameters also displayed statistically significant difference between left and right sided values. Additionally discrepancies were noticed on comparison of the present data with the previous studies. These discrepancies could be due to racial dissimilarities and regional variations.

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