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Morphometric Study of Adult Dried Human Scapulae in South Indian Population

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Abstract

Background: Scapula is one of the important components of shoulder girdle. According to clinical experts several shoulder pathologies found to have an anatomical basis. The scapula is one of the bones found to present several variation based on race, sex, and region. Thus the osteometric measurements and morphometric knowledge of the scapula is essential to understand normal anatomy, for comparative anatomy, to treat different shoulder disorders and also for manufacturing of prosthetic products. *Aims and Objectives:* To obtain the baseline data of morphometric measurements of dry human scapula among South Indian Population. To compare the clinical importance of obtained parameters with anthropometric studies done by other authors. *Materials and Methods:* The following study was conducted on 105 dry adult human scapula obtained from the students of first MBBS. The measurements was taken using digital vernier calliper and obtained data was statistically analysed using student '*t*' test using SPSS version 20. *Results and Conclusion:* The anthropometric measurements of the adult dry human scapula among South Indian Population are reported in this paper. This data could be of helpful for surgeons, anthropologists to understand the normal anatomy of scapula which play an important role in the management of different shoulder pathologies, rehabilitation of shoulder injuries, contribute to demographic studies, and also assist in forensic cases.

Keywords: Shoulder; Scapula; Girdle; Morphometric; Injury.

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Introduction

The Human Scapula is one of the bones of shoulder girdle. It is a flat bone, triangular in shape and is situated in the posteriolateral part of chest wall overlapping the second to seventh ribs. The Scapula presents 2 surfaces-costal and dorsal, 3 borders-lateral, medial and superior, 3 angles-lateral, inferior and superior,and 3 processes-spine, acromian and coracoid. Lateral angle bears the glenoid cavity and represents head of the scapula and rest represents the body of the scapula. The body has subscapular fossa on its costal surface and supraspinous and infraspinous fossa on its dorsal aspect with triangular spine in between which continues as acromion process laterally. The superior border continues laterally as coracoid process. The coracoacromial arch is formed by the coracoid and acromial processes connected by the ligament.Various muscles attached to the Scapula act on the gleno-humeral joint, stabilises and also brings about various movements at that joint.[1]

The morphometry of the acromion process of the scapula is an important factor implicated in impingement syndrome of the shoulder joint.[2] The phylogenic, ontogenic and racial variations of the scapula make it as one of the most interesting bones for research. Also the dimensions of the scapula are of major importance in the patho-mechanics of rotator

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cuff disease, total shoulder arthroplasty, recurrent shoulder dislocation, for comparative anatomy, for surgical procedures and for manufacturing prosthetics.[3] The aim and objectives of the present study was to record the morphometrical data of the scapula among the South Indian population and to compare the results obtained from the present study with previous studies done in different populations which helps to establish possible morphofunctional correlations related to race, geographic region and literature data.

Materials and Methods

The present study includes 105 dried adult human scapulae of unknown age and sex obtained from the Department of anatomy, Kodagu Institute of Medical Sciences, Madikeri. 51 scapulae were from left side and 54 were from right side. Deformed, damaged and paediatric scapulae was excluded from the study. The following measurements were taken using digital vernier callipers of 0.1 mm precision and the mean and standard deviation were calculated and tabulated. The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20. The morphometric values of the two sides were analysed using a Student *t*-test. Statistical significance was set $p \leq 0.05$ (**Figs.1 and 2**).

Scapular length (AB): The distance from the superior angle to the inferior angle of scapula.

Scapular width (CD): The maximum transverse diameter between the medial border of the scapula, where the spine meets the body of the scapula, and the anterior lip of the glenoid.

Acromion length (EF): The distance between tip and midpoint of posterior border of acromion process.

Acromion breadth (GH): The distance between the lateral and medial borders at the midpoint of the acromion process.

Projection length of scapular spine (IJ): The distance from the medial edge of the scapula to the lateral edge of the acromion process.

Superior-Inferior glenoid diameter (KL): The maximum distance measured from the inferior point on the glenoid margin to the most prominent point of the supraglenoid tubercle.

Anterior-Posterior glenoid diameter (MN): The maximum breadth of the articular margin of the glenoid cavity perpendicular to the glenoid cavity height.

Length of the coracoid process (OP): The distance from the base to the tip of the coracoid process.

Acromio-Coracoid distance (QR): The distance between the tip of acromion and tip of the coracoid processes.

Acromio-Glenoidal distance (QS): The distance between tip of acromion process and supraglenoid tubercle.

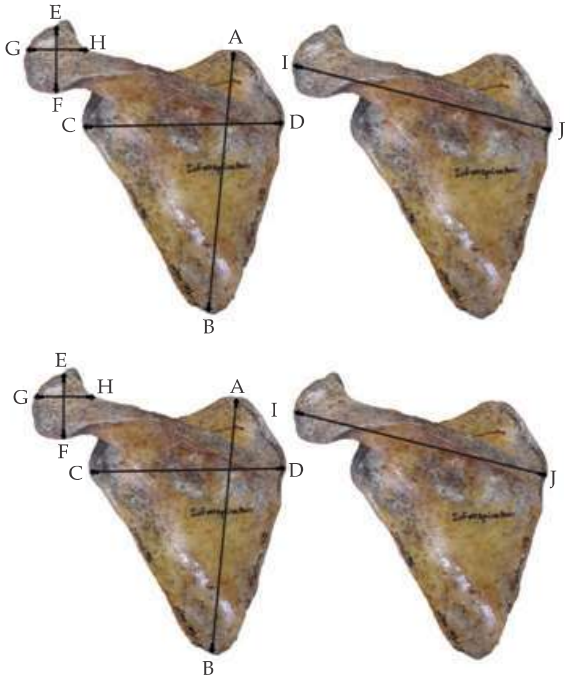

Fig. 1: AB: Scapular length; CD: Scapular width; EF: Acromion length; GH: Acromion breadth; IJ: Projection length of scapular spine.

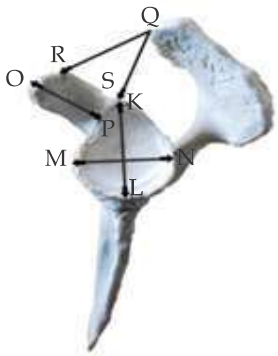

Fig. 2: KL: Superior-Inferior glenoid diameter; MN: Anterior-Posterior glenoid diameter; OP: Length of the coracoid process; QR: Acromio-Coracoid distance; (QS): Acromio-Glenoidal distance.

Results

The maximum length of scapula in the present study ranged from 109 –176 *mm* on the left side and

107–160 *mm* on the right with mean value of 138.9–139.6 *mm* and standard deviation of 11.4–12.4 *mm* respectively. The maximum width of the scapula in the present study ranged from 77 *mm*–113 *mm* on the left side and 84–114 *mm* on the right with mean value of 96.6–99.2 *mm* and standard deviation of 7.7–7.7 *mm* respectively which was statistically insignificant (**Table 1**).

The Mean and Standard deviation of superior inferior diameter and anterioposterior diameter of glenoid cavity was 36.1 ± 3.6 *mm* and 23.2 ± 2.5 *mm* on left side and 35.6 ± 2.9 *mm* and 20.3 ± 4.5 *mm* on right scapula respectively.

The length and breadth of Acromian process ranged between 13–44 *mm* and 17–28 *mm* with Mean and Standard deviation of 33.4 ± 5.9 *mm* and 22.8 ± 2.5 *mm* on left side and ranged between 27 and 57 *mm* and 11–30 *mm* with Mean and Standard deviation of 42.8 ± 6.6 *mm* and 23.3 ± 3.1 *mm* on right side respectively.

The Length of the coracoid process ranged between 28–50 *mm* and 31–49 *mm* with Mean and Standard deviation of 38.4 ± 4.4 *mm* and 39.1 ± 4.3 *mm* on left and right side respectively.

The Mean and Standard deviation of Projection length of scapular spine was 129.1 ± 8.8 *mm* and 129.3 ± 10.3 *mm* on left and right side respectively.

The Acromio-Coracoid distance and Acromio-Glenoidal distance was 37.3 ± 6.4 *mm* and 26.4 ± 4.4 *mm* on left and 41.6 ± 6.7 *mm* and 23.5 ± 4.1 *mm* on right respectively.

Table 1: Scapular measurements.

Sl. no.	Scapular measurements	Mean ± SD (*mm*)		Range (*mm*)	
		Left	Right	Left	Right
1	Scapular length	138.9 ± 11.4	139.6 ± 12.4	109–176	107–160
2	Scapular width	96.6 ± 7.7	99.2 ± 7.7	77–113	84–114
3	Superior-Inferior glenoid diameter	36.1 ± 3.6	35.6 ± 2.9	31–54	29–41
4	Anterior-Posterior glenoid diameter	23.2 ± 2.5	20.3 ± 4.5	17–30	11–28
5	Acromion length	33.4 ± 5.9	42.8 ± 6.6	13–44	27– 57
6	Acromion breadth	22.8 ± 2.5	23.3 ± 3.1	17–28	11–30
7	Length of the coracoid process	38.4 ± 4.4	39.1 ± 4.3	28–50	3– 49
8	Projection length of scapular spine	129.1 ± 8.8	129.3 ± 10.3	111–144	108–148
9	Acromio-Coracoid distance	37.3 ± 6.4	41.6 ± 6.7	21–52	28–60
10	Acromio-Glenoidal distance	26.4 ± 4.4	23.5 ± 4.1	16–35	15–36

Discussion

Each individual presents with variations in shoulder anatomy, overall conditioning and fitness and degrees of shoulder laxity that makes the precise evaluation of pathologic lesions difficult. Even though the variation in the morphology of Scapula are few, its anthropometric measurements have great importance in understanding the shoulder girdle pathologies and also useful in treating the various disorders of shoulder joint and also in designing shoulder implants.[4]

The Scapular length in the present study is lower when compared with the other studies (**Table 2**). whereas the scapular width is similar with the studies conducted by Lingamdenne PE *et al.*[6] Wael amin *et al.*[3] has reported higher scapular length and width of 151.20 ± 9.47 *mm* and 107.01 ± 9.00 *mm* on left side and 151.05 ± 8.42 *mm* and 107.43 ± 8.07 *mm* on right side in Egyptian population. Manju

Table 2: Comparison of Scapular length and width.

Sl. no.	Authors	Scapular length Mean ± SD (*mm*)		Scapular width Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Jaskaran singh *et al.*[5] (2013)**	145 ± 11.3	144.6 ± 12.2	106.5 ± 7.5	104.6 ± 7.7
2	**Wael Amin *et al.*[3] (2015)**	151.20 ± 9.47	151.05 ± 8.42	107.01 ± 9.00	107.43 ± 8.07
3	**Lingamdenne PE[6] (2016)**	141.5 ± 9.7		98.6 ± 6.9	
4	**Manju Madhavan *et al.*[4] (2017)**	132.4 ± 11.05	130.1 ± 10.9	89.7 ± 8.8	90.9 ± 6.2
5	**Present study (2018)**	138.9 ± 11.4	139.6 ± 12.4	96.6 ± 7.7	99.2 ± 7.7

Madhavan *et al.*[4] has reported lower scapular width in South Indian population. These different values could be due to racial, ethnic, and regional variations. This data can be used for demographic studies, comparative studies among different population groups and forensic cases.

The superior inferior diameter of glenoid cavity in the present study showed near values with the study conducted by Lingamdenne PE *et al.*[6] who reported the values of 36.85 ± 3.17 *mm* irrespective of side of the scapula. Ajay M Parmar *et al.*[7] reported the higher values of 37.46 ± 2.92 *mm* on left and 37.31 ± 2.91 *mm* right side and Manju Madhavan *et al.*[4] in their study recorded the lower values of 34.92 ± 2.14 *mm* on left and 36.92 ± 1.81 *mm* on right side than that of the present study.

Anterior-Posterior glenoid diameter as reported by Manju Madhavan *et al.*[4] was 22.19 ± 1.52 *mm* on left and 23.91 ± 2.91 *mm* on right side and Ajay M Parmar[7] recorded 25.9 ± 2.09 *mm* on left and 25.7 ± 2.32 *mm* on right side. Lingamdenne PE *et al.*[6] reported 25.07 ± 2.55 *mm* irrespective of the side of scapula. However, Mamatha T *et al.*[8] in their study showed lower values of 19.6 *mm* on left and 20.1 *mm* on right respectively. The anteriosuperior diameter of glenoid cavity in the present study is lower on right side than left side whereas its contradictory to the results made by the other authors compared in having higher values on right side than on the left scapula.

Wael amin *et al.*[3] reported higher superior inferior and anterioposterior glenoid diameter of 39.01 ± 2.49 *mm* and 27.99 ± 2.55 *mm* on left side and 38.88 ± 2.63 *mm* and 28.31± 2.38 *mm* on right side scapula respectively. They also reported higher values of superior inferior glenoid diameter on left than right which is similar to the present study but contradictory to the results of other authors compared.

The precise knowledge of the glenoid anatomy is necessary to treat the glenoid fractures, rotator cuff tears, bony Bankarts lesion.[6] When the glenoid notch is distinct, the glenoid labrum is often not attached to the rim of the glenoid at the site of the notch and can be a predisposing factor in anterior dislocation of the shoulder joint.[3]

The length and breadth of the acromion is of paramount importance in the management of rotator cuff tears and impingement syndrome.[6] The results are compared with previous authors (**Table 3**). Wael Amin *et al.*[3] reported higher dimensions in the Acromian process and the present study showed lower values than than the other studies compared.

The undersurface of the anterior one third of the acromion was pinpointed by Neer CS as the area

Table 3: Comparison of Morphometric measurements of Acromian process with the previous studies.

Sl. no.	Authors	Length of Acromian process Mean ± SD (*mm*)		Breadth of Acromian process Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Jaskaran Singh** *et al.*[5]	45.8 ± 5.3	46.4 ± 5.2	23 ± 2.4	23.4 ± 2.7
2	**Wael Amin** *et al.*[3]	53.28 ± 4.1	52.33 ± 4.2	32.01 ± 3.7	32.09 ± 3.2
3	**Lingamdenne PE**[6]	43.22 ± 5.7		24.64 ± 2.9	
4	**Manju Madhavan** *et al.*[4]	42 ± 5.2	42.1 ± 4.1	24.9 ± 2.9	27.3 ± 3.8
5	**Present study**	33.4 ± 5.9	42.8 ± 6.6	22.8 ± 2.5	23.3 ± 3.1

responsible for impinging upon the components of the rotator cuff (especially the supraspinatus tendon). He noted a characteristic ridge of spurs (enthesophytes) on the anterior acromion process. The relationship of acromial morphology to the clinical syndrome of shoulder impingement was an important precursor to rotator cuff tears in 95% of Neer's cases.[2]

Lingamdenne PE *et al.*[6] reported the coracoid length as 39.04 ± 4.16 *mm*, slightly higher to our finding of 38.82 ± 4.16 *mm* and the projection length of scapular spine as 123.35 *mm* which was lower than the present study which showed 129.23 *mm* irrespective of side of Scapula. It is important to have the knowledge of coracoid length while planning for a coracoid osteotomy in the management of coracoid impingement syndrome.

Acromiocoracoid distance and acromioglenoid distance in the present study showed 37.3 *mm* and 26.4 *mm* on left side and 41.6 *mm* and 23.5 *mm* on right side respectively. The results are compared with previous studies (**Table 4**). Acromiocoracoid distance showed higher right side values in the present study which was statistically significant ($p = 0.0011$) and also showed slightly higher values than the study done by the previous authors. The

Table 4: Comparison of Acromiocoracoid distance and Acromioglenoid distance with previous studies.

Sl. no.	Authors	Acromiocoracoid distance Mean ± SD (*mm*)		Acromioglenoid distance Mean ± SD (*mm*)	
		Left	Right	Left	Right
1	**Mansur** *et al.*[2]	39.39 ± 5.32	39.03 ± 6.2	31.97 ± 3.96	31.83 ± 3.66
2	**Wael Amin** *et al.*[3]	31.10 ± 3.55	31.58 ± 3.09	27.11 ± 3.08	27.67 ± 3
3	**Lingamdenne PE** *et al.*[6]	31.85 ± 4.4		24.46 ± 3.68	
4	**Ritu** *et al.*[9]	37.96	29.86		
5	**Present study**	37.3 ± 6.4	41.6 ± 6.7	26.4 ± 4.4	23.5 ± 4.1

acromio coracoid and acromio-glenoid distances have a significant role in rotator cuff lesions, and impingement syndromes that affect the shoulder and also play an important role in their management.[6]

Racial and sexual differences can interfere in the development of bone projections, providing alterations such as size and morphology. These alterations can occur in scapulae and may affect the glenohumeral stability.[3]

Conclusion

The purpose of the present study was to record the basic morphometric values of the Scapulae in South Indian population which helps the medical practitioners to understand, treat the different shoulder joint disorders, and help in designing implants for the shoulder joint. It can also be used for demographic studies, assist in forensic cases, and rehabilitation of players who sustained sports injuries.

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