



A STUDY OF PATTERNS AND OSTEOMETRIC PARAMETERS OF SCAPULA IN NORTH BENGAL POPULATION WITH ITS CLINICAL SIGNIFICANCE

Anatomy

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ABSTRACT

AIM: To study morphological patterns and osteometric parameters of acromion process and glenoid cavity along with its clinical importance.

MATERIALS & METHODS: 68 dry scapula of unknown sex and age were studied. In addition to acromion parameters glenoid cavity parameters and coracoids process parameters, the maximum scapular length, width, acromio-coracoid and acromio-glenoid distance were also measured.

RESULT: Among the morphological parameters, quadrangular shape of tip of acromion was commonly found. 57.35% scapula had smooth inferior surface. Entheseophytes presented in 32.35% scapula mainly in type III. Type I acromion process and oval shaped glenoid cavity was common. On comparing various osteometric parameters for significance, correlation was found between Coracoid Length of both sides, scapular length and Acromial Length, Scapular Width and Acromial Width, Glenoidal width and height, Acromion-coracoid and Acromio-glenoid dist.

KEYWORDS

scapula, morphological patterns, osteometric parameters

INTRODUCTION

Variations of scapula is an important research field when it comes to analysis of shoulder pathologies. Osteometric parameters of scapula and its pattern variation will help us to analyse these variations clinically.

Acromion process projects forward at right angles from lateral end of spine, the lower border of spine continues as the acromion angle [1]. Anterior third of acromion process, coracoacromial ligament and coracoids process form the coracoacromial arch which has a subacromial space 1-1.5 cm wide containing subacromial bursa, rotator cuff and tendon of long head of biceps [2]. Parameters like acromial width [AW], acromial length [AL], shape of acromion, type of acromion, inferior surface of acromion and acromion-coracoid [A-Cdist] distance will help in identification of anatomical factors for impingement syndrome and rotator cuff tears. Bigliani et al, classified acromial morphology into 3 types out of which type III (hooked) is most commonly associated with impingement syndrome [3].

Coracoid process arises from the upper border of the neck of scapula bending sharply to project forwards and slightly laterally [1]. Coracoids length may be related to coracoid impingement syndrome [4].

Glenoid cavity is the lateral angle, truncated and broad pointing forwards laterally and slightly upwards [1]. Maximum glenoidal width [MGW], maximum glenoidal length [MGL], acromio-glenoid distance [A-G dist] and shape of glenoid cavity were noted and their clinical correlation with shoulder dislocation, rotator cuff disease was determined. The prognostic outcome of shoulder arthroplasty for treatment of glenohumeral osteoarthritis will also be determined by these parameters [5].

The current study to record the morphometric data of acromion process and glenoid cavity in North Bengal population will help us to compare the data obtained from other geographical regions. The data can also help in better understanding and management of impingement syndrome, rotation cufftear, gleno-humeral instability and prognosis of orthopaedic joint replacement surgeries.

MATERIALS AND METHODS

68 dry intact scapula from Department of Anatomy, North Bengal Medical College, Darjeeling, West Bengal were studied. Of the 68 scapula, 34 belonged to right and 34 to left.

INCLUSION CRITERIA: adult dry intact scapula with clear features.

EXCLUSION CRITERIA: broken, defective, unossified scapula.

Morphological and osteometric measurements were taken of acromion

process, coracoids process and glenoid cavity. Linear measurements were taken using sliding vernier callipers (accurate to 0.1mm) and angular measurements were taken using goniometer.

Morphological Parameters

I. Of Acromion process

- 1) Shape of tip of acromion process- boot shape / beak shape / flask shaped / leaf shaped / quadrangular / rectangular / square / triangular [6], (Figure 1).
- 2) Type of inferior surface of acromion process- rough / smooth.
- 3) Type of acromion process- measuring angle of slope formed by intersection of a line from tip of hook to junction of hook and another line along under surface of acromion. Angles from 0° - 12° = type I (flat), angles from 13° - 27° = type II (curved), angles $>27^{\circ}$ = type III (hooked) [2], (Figure 2).

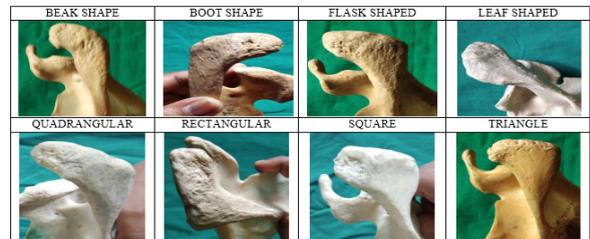


Figure 1: Showing different shapes of acromion process



Figure 2: Measurement of angle of slope of acromion, and its classification

II. Of glenoid cavity

- 4) Shape of glenoid cavity [7] – a sheet was kept on the glenoid cavity and with a pencil the rim was rubbed for a tracing [7]. It was either oval, pear shaped or inverted comma shaped [8].

Osteometric Parameters

I. Scapular parameters

- 1) Maximum scapular width – maximum distance between the medial border of the scapula where the spine meets the body of the scapula and anterior lip of glenoid cavity.
- 2) Maximum scapular length – maximum distance between superomedial and inferior angle.

II. Acromion parameters

- 1) Acromial width – distance between lateral and medial borders at midpoint of the process.
- 2) Acromial length – distance between tip and midpoint of the posterior border of acromion process.
- 3) Acromio-glenoid distance – distance between tip of acromion to supraglenoid tubercle.
- 4) Acromio-coracoid distance – distance between tip of acromion to tip of coracoids.

III. Coracoid parameter

- 1) Coracoid length – distance from base to tip of coracoids[9].

IV. Glenoid cavity parameter

- 1) Maximum glenoid width – maximum breadth of the articular margin of the glenoid cavity.
- 2) Maximum glenoid height – maximum distance from inferior point on the glenoid margin to the most prominent point on the supraglenoid tubercle.

STATISTICAL ANALYSIS

The measurements were taken thrice by two investigators and the mean value was tabulated. The data was analysed using Statistical Package for the Social Sciences (SPSS) version 20. The morphometric values of the two sides were analysed using an unpaired t-test. Statistical significance was set at $p < 0.05$ for comparison of the data obtained from the present study with earlier published reports.

RESULT

According to morphological parameters – the shape of tip of acromion process, quadrangular and square shape was maximally found on right and boot shape on left. Least distribution of rectangle and beak on right and leaf shape on left. Figure 3 depicts the percentage of various shapes. On examining type of acromion process according to slope type I (flat) was found maximally on both right and left side while type III (hooked) had the least incidence bilaterally. Figure 4 shows the distribution of the types according to slope of angle. The inferior surface of acromion had equal incidences of smooth and rough surface on right while on left smooth surface incidence was more. Entheseophytes were seen in 32.2% of the scapula more in type III. Oval shape of glenoid cavity had maximum incidence on both sides. Pear shaped had least incidence on right and inverted comma least on left. Incidences of various morphological parameters is shown in Table 1.

The mean and standard deviation of all the morphometric parameters on right and left side scapula are shown in Table 2. P-value was calculated for all variables using unpaired t-test, in which coracoids length of both sides was found to have statistical significance.

Statistical significance was also calculated to be highly significant between MSW/AW, MSL/AL, A-C dist/A-G dist, MGH/MGW.

Table 1: Incidences of morphological parameters

Parameter	Right scapula		Left scapula		Total	
	number	%	number	%	number	%
Shape of tip of acromion process						
Beak	2	5.55	6	18.75	8	11.76
Boot	5	13.88	7	21.87	12	17.64
Flask	6	16.66	3	9.37	9	13.23
Leaf	3	8.33	0	0	3	4.41
Quadrangular	7	19.44	6	18.75	13	19.11
Rectangle	2	5.55	5	15.62	7	10.29
Square	7	19.44	2	6.25	9	13.23
Triangle	4	11.11	3	9.37	7	10.29
Type of inferior surface						
Rough	17	50	12	35.29	29	42.64
Smooth	17	50	22	64.7	39	57.35
Type of Acromion process according to shape						
Type I (Flat)	20	58.82	17	50	37	54.41
Type II (Curved)	7	20.58	9	26.47	16	23.52
Type III (Hooked)	7	20.58	8	23.52	15	22.05
Shape of glenoid cavity						
Oval	14	41.18	17	50	31	45.59
Pear	7	20.59	10	29.41	17	25
Inverted comma	13	28.23	7	20.59	20	29.41

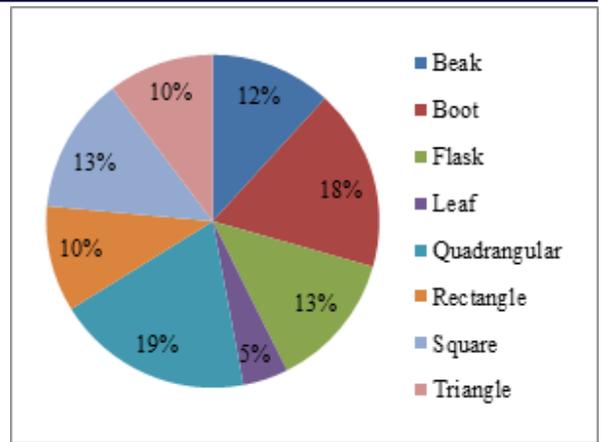


Figure 3: Pie diagram showing % of various shape of tip of acromion process of scapula parameters

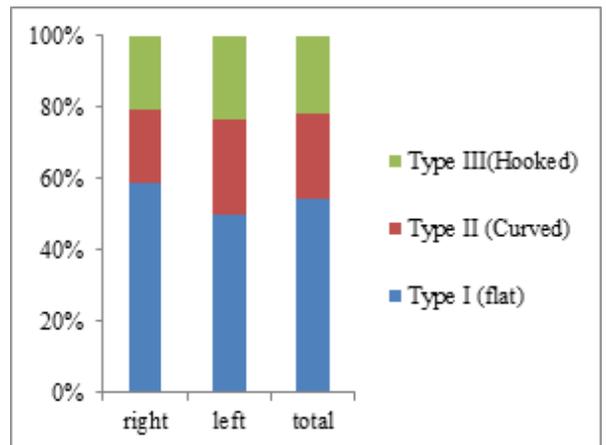


Figure 4: Distribution of type of acromion process according to angle of slope

Table 2: Mean, Standard deviation and P-value of various osteometric parameters

Parameter	Right scapula		Left scapula		Total		P value
	Mean	SD	Mean	SD	Mean	SD	
MSW	95.8	± 7.16	96.9	± 6.15	96.3	± 6.6	>0.05
MSL	142.5	± 12.74	139.9	± 15.39	141.2	± 14.11	>0.05
AL	42.8	± 6.87	40.1	± 8.11	41.4	± 7.61	>0.05
AW	26.1	± 3.37	25.2	± 3.75	25.6	± 3.62	>0.05
A-C dist	30.4	± 4.78	30.7	± 5.37	30.6	± 5.01	>0.05
A-G dist	26.9	± 3.42	26.0	± 3.59	26.4	± 3.52	>0.05
MGH	37.9	± 3.88	36.3	± 4.65	37.1	± 4.32	>0.05
MGW	24.6	± 2.28	24.2	± 2.73	24.2	± 2.54	>0.05
CL	40.6	± 4.23	38.0	± 5.34	39.3	± 4.92	<0.05

MSW= Maximum scapular width; MSL = Maximum scapular length; AL = Acromion length; AW = Acromion width; A-C dist = Acromio-coracoid distance; A-G dist = Acromio-glenoid distance; MGH = Maximum glenoid height; MGW = Maximum glenoid width; CL = Coracoid length

DISCUSSION

Shape of acromion differs due to genetic and acquired causes and age being the main acquired cause, as with progression of age the shape along with the type changes from flat to hooked increasing the tendency of impingement. Mansur et al [3] classified the shape of acromion into triangle quadrangular and tubular out of which quadrangular constituted a maximum of 52.94%. Gupta et al [6] classified it into quadrangular, boot, square and hockey stick out of which quadrangular was maximum 44%. In our study quadrangular shape contributed maximally of 19.11% and leaf shape contributed the least with 4.41%. The shape of the acromion was found to have correlation with severity of impingement syndrome, outcome of conservative therapy and need for surgical

intervention.

- Sangiampong A et al [13], Coskun N et al [15], Singh Jet al [16], Schippinger G et al [17] found the distribution of acromion type as type I(flat)3.2%, 10%,22.5% and 67.7% respectively; typeII (curved) 93.5%,73%, 38.8%and 32.3%; type III (hooked) 3.2%,17%,38.8% and 0%. In the current study, type I constituted the maximum with findings similar to Schippinger G et al [17] with 54.4%. According to Collipal E et al [18] type III was observed to have a two-fold increase in chances of rotator cuff syndrome, hence making this parameter clinically important.
- Current study shows inferior surface of anterior third of the acromion process to be smooth in 57.36% and rough in 42.64% these corresponded to the findings of Singh J et al [16] who found a greater proportion of smoothed inferior surface(55.8%) compared to rough surface(44.2%). Degenerative changes in scapula are mainly in the form of enthesophytes ,spurs and rough inferior surface. In our study enthesophytes were found in 32.35% cases and more commonly in type III scapula. This finding was similar to Natsis K et al [19]who also found enthesophytes more in type III.
- Nasr el-din WA et al [10], Coskun N et al [13], Prescher A et al [20]found oval shape of glenoid cavity and inverted comma shaped constituting the maximum and minimum respectively. In our study we found the oval shape to contribute maximally (45.59%) and pear shape contributed the least (25%). Variation of shape will help in understanding shoulder dislocation and meticulous design of prosthesis.
- Aigbogun (Jr) EO et al [21], Lingandenne PE et al [9], Paraskevas G et al [2], Chavan SR et al [22] and Kavita P et al [23] found MSW to be 143.80±13.84, 141.49±9.74, 147.6, 137±13.67, 141.1mm while in current study it was found to be 141.2±14.11 (R=142.5±12.73, L=139.9±15.39)
- The MSW as found by Lingandenne PE et al [9], Paraskevas G et al [2], Chavan SR et al [22] and Kavita P et al [23]. Was 141.49mm, 147.6mm, 99.32mm, 105.5mm respectively. In our study we found MSW to be 96.3±6.6 (R=95.8±7.16 L=96.9±6.14).P-value was found for both MSL and MSW but was not found significant.
- The current value for MGW was 24.4±2.54 closer to the values obtained by Chavan SR et al [22] (25.08±2.53) and Lingandenne PE et al [9] (25.07±2.55) values obtained by Nasr el-din WA et al [10] was 28.15±2.58 which was higher than our obtained value.
- MGH found by Chavan SR et al [22], Lingandenne PE et al [9] and Nasr el-din et al [10] were 36.83±3.18, 36.5±3.17 and 38.95±2.73 respectively while the current value was found to be 37.14±4.32(R=37.9±3.88, L=36.32±4.64). According to Rajput HB et al [5] and Mamatha T et al [7]. Right glenoid numerical values were higher than left as in our study too, but there was no statistical significance as P-value was >0.005. knowledge of glenoid parameters is important for pathogenesis of joint instability, design of prosthesis, treatment of glenoid fractures [24], rotator cuff tear [25] and Bony Bankart's lesions [26]. We calculated the p value between MGW and MGH and found it to be highly significant <0.000. Aigbogun (Jr) EO et al [21], in his study deduced that higher was the difference between MGH and MGW more is the possibility of Gleno humeral joint problems. He also found a statistical significance between the two values as in our study.
- The mean AW and AL in our study was found to be 25.64±3.62 and 41.44±7.61 respectively. Lingandenne PE et al [9] (24.64±2.89 and 43.22±5.75), Chevan SR et al [22]. (23.22±2.91 and 42.91±2.87) Paraskevas G et al [22]. (22.3 and 46.1), Nasr el-din et al [10] (32.05±3.88 and 52.81±4.08). according to Edelson JG et al [27]. Length of acromion was related to degenerative changes and it also determined the acromion shape. Antezberger H et al [28]. Stated that AL and AW play an important role in impingement syndrome but in our study no significance was found between both. Correlation between MSL and AL, MSW and AW were found to be highly significant similar to studies done by Gupta C et al [6].
- Lingandenne PE et al [9], Paraskevas G et al [22] and Nasr el-din et al [10] found A-C dist and A-G dist to be 31.85±4.4 and 24.46±3.68, 28.1 and 17.7, 31.34±6.4 and 27.39±0.1 respectively. In the present study it was found to be 30.62±5.01 and 26.42±3.52. both the parameters were found to be significantly related (<0.005) while no significance was noted by Gupta C et al [6].
- The mean CL in our study was found to be 39.99±4.92 (r=40.62±4.23, L=38.01±5.34) Lingandenne PE et al [9] (39.04±4.05), Chavan SR et al [22] (40.01±4.05), Coskun N et al [13] (19.4) and Sitha P et al [29] (37.8) respectively. The

knowledge of coracoids length is useful in planning for coracoids osteotomy for management of coracoids impingement syndrome [30]. the coracoids length of both the sides were found to be significant with P value 0.028.

CONCLUSION

The above study compared with other studies of different regions revealed the racial and ethical differences. The morphological and osteometric values could be of help to orthopedicians for diagnosis (anatomical factors responsible) and treatment of common shoulder pathologies like rotator cuff tear, joint dislocation, impingement syndrome. The values could be used to design implants for people of North Bengal region. Data could also be used for forensic cases, demographic study and rehabilitation of players who sustained injuries during sports.

REFERENCES

- [1] Simon M Lambert. Shoulder girdle and arm. In: Standing S (ed) 41st. Grey's Anatomy, The Anatomical basis of clinical practice. Elsevier Churchill Livingstone:2016;797.
- [2] Paraskevas G, Tzaveas A, Papazogas B, Kitsoulis P, Natsis K, Spanidou S. Morphological parameters of the acromion. *Folia Morphol (warsz)* 2008;67:255-60.
- [3] Bigliani LU, Morrison DS, April EW. The morphology of the acromion and its relation to rotator cuff tears. *Orthop Trans*. 1986;10:228.
- [4] Mc Brain L, Simonds E, Iwanaga J, Shane R, Tubbs. Review of the pathology and congenital anomalies of the coracoids process with clinical application. *Transitional research in anatomy*. vol 10, march 2018;4-6.
- [5] Rajput HB, Vyas KK, Shroff BD. A study of morphological pattern of glenoid cavity of scapula. *National J Med Resc*. 2012;2(4):504-07
- [6] Gupta C, Priya A, Kalthur SG, D' Souza AS. A Morphometric study of acromion process of scapula and its clinical significance. *Chrismed Journal of Health and Research*. 2014;13:164-69.
- [7] Mamatha T, Pia SR, Murlimanju BV, Kalthur SG, Pai MM, Kumar B. Morphometry of glenoid cavity. *Online J Health Allied Scs*. 2011;10(3):7.
- [8] Prescher A, Klumpen T. Does the glenoid cavity of scapula show sexual dimorphism? *J Anat*. 1995;186:223-26.
- [9] Lingandenne PE, Morapaka P. Measurements and analysis of orthopometric measurements of the human scapula in Telangana region, India. *Int. J. Anat . Res*. 2016;4(3):12677-83.
- [10] Nasr el-din WA, Mohommad Ali MHA. Morphometric study of the patterns and variations of the acromion and glenoid cavity of the scapula in Egyptian population. *Journal of Clinical and Diagnostic Research* 2015;9(8):8-11.
- [11] Mansur DI, Khanal K, Haque MK, Sharma K. Morphometry of acromion process of human scapula and its clinical importance among Nepalees population. *Kathmandu Univ Med J*. 2012;10:33-6.
- [12] Wang JC, Hatch JD, Shapiro MS. Comparison of MRI and radiographs in the evaluation of acromion morphology. *Orthop* 2000;23(12):1269-71.
- [13] Sangiampong A, Chompoopong S, Sangvichien S, Thongtong P, Wangjittraporn S. The Acromial morphology of Thai in relation to gender and age: study in scapula dried bone. *J Med Assoc Thai* 2007;90(3):502-7.
- [14] Saha S, Vasudeva N, Paul S, Gautam VK. Study of acromion morphology in Indian population. *Rev Arg de Anat Clin* 2011;3(2):84-88.
- [15] Coskun N, Kaarali K, Cevikal C, Demirel BM, Sinsel M. Anatomical Basics and variation of the scapula in Turkish adults. *Saudi Med J* 2006;27(9):1320-25.
- [16] Singh J, Puhuja K, Agarwal R. Morphometric parameters of the acromion process in adult human scapula. *IJBAMR* 2013;vol2(8):1165-70.
- [17] Schippinger G, Bailey D, Mac Nally EG, Kiss J, Carr AJ. Anatomy of the normal acromion investigated using MRI. *Langenbecks Arch Chir*. 1997;382:141-44.
- [18] Collipal E, Silva H, Ortega L, Espinoza E, Martinez C. The acromion and its different forms. *Int J. Morphol* 2010;28(4):1189-92.
- [19] Natsis K, Tsikaras P, Totlis T, Giginis I, Skandalakis P, Appell HJ. Correlation between the four types of acromion and the existence of enthesophytes: a study of 423 dried scapula and review of the literature. *Clin Anat* 2007;20:267-72.
- [20] Prescher A, Klumpen T. The glenoid notch and its relation to the shape of the glenoid cavity of scapula. *J. Anat* 1997;190:457-60.
- [21] Aigbogun (Jr) EO, Oladipo GS, Oyakhire MO, Ibeacher PC. Morphometry of the glenoid cavity and its correlation with selected geometrical measurements of the scapula. *Bangladesh Journal of medical sciences* vol 16(4):572-79.
- [22] Chavan SR, Bhoir M, Verma S. A study of anthropometric measurements of human scapula in Maharashtra, India. *MedPulse- International Journal of Anatomy*. 2017;1(2):23-6.
- [23] Kavita P, Jaskaran S, Geeta. Morphology of coracoid process and glenoid cavity in adult human scapula. *International Journal of Analytical Pharmaceutical and Biomedical Sciences*. April-June 2013;2(2):19-22.
- [24] Drik PH, VanOostreen ,Olivien PP, Teusmerman, Breger BJ, Noort AV, Robinsin M. Glenoid fracture: a review of pathology, classification, treatment and results. *Acta Orthop. Belg*. 2014;80:88-98.
- [25] Pandey V, Jaap WW. Rotator cuff tear: a detailed update. *Asia-Pacific Journal of sports Medicine, Arthroscopy, Rehabilitation and Technology*. 2015 Jan;2(1):1-14.
- [26] Grondin P, Leith J. Combined large Hill-Sachs and Bony Bankart lesion treated by Latarjet and partial humeral head resurfacing: a report of 2 cases. *Can. J. Surg*. 2009 Jun;52(3):249-54.
- [27] Edelson JG, Taitz C. Anatomy of coracoacromial arch: relation to degeneration of the acromion. *J. Bone Joint Surg Br*. 1992;74:589-94.
- [28] Anetzberger H, Putz R. The scapula: Principals of construction and stress. *Acta Anat (Basel)* 1996;156:70-80.
- [29] Sitha P, Nopparatr S, Aporn CD. The scapula: osseous dimensions and gender dimorphism. *Thais Siriraj HSOP*. 2004;56(7):356-65.
- [30] Dines DM, Warren RF, Allan E, Pavlov IH. The coracoids impingement syndrome. *The Journal of Bone and Joint Surgery*. 1990;72-B:314-6