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A study of acromion morphology and morphometry in north indian population and its significance in subacromial impingement syndrome and rotator cuff tears

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Abstract. *Introduction*. The acromion process serves as a point of attachment for various muscles and ligaments and is a pivotal factor in the development of shoulder impingement syndrome and rotator cuff pathology. The study aims to evaluate the acromion process of dry human scapulae in residents of North India and understand the implications of these in relation to shoulder impingement syndrome and rotator cuff pathology. *Material and Methods*. The present study comprised of 100 adult scapulae of unknown sex obtained from Department of Anatomy, Government Medical College, Amritsar. The acromion process was studied for shape of tip of acromion, inferior surface, enthesophytes, os acromiale, acromial facet, maximum length, width, anterior thickness, distance between tip of acromion and coracoid. *Results*. The most common shape of tip was found to be intermediate. The most common shape of acromial facet observed was oval and it was more medially inclined. The inferior surface of acromion was rough in 79% bones. Enthesophytes were found in 16 bones which were more common in type II acromion and right side. Width, Length, Anterior Thickness, distance between tip of acromion and coracoid was found to be less on left side as compared to the right side. *Discussion*. The majority of the parameters were observed to be higher on the right side which proved to be significant for orthopedicians. Facts about the common variant and morphometric proportions of acromion process can support to improve understanding and preparation for the treatment of rotator cuff pathology due to the impingement syndrome.

Keywords: acromion, shoulder pain, shoulder impingement syndrome, subacromial impingement syndrome.

INTRODUCTION

The acromion process is a bony projection or extension of the scapula, the shoulder blade. Being a prominent feature of the scapula, it plays significant role in the structure and function of the shoulder joint. It forms the outermost part of the shoulder blade and is easily palpable at the top of the shoulder. It articulates with the clavicle (collarbone) to form the acromioclavicular joint, which is important for the movement and stability of the shoulder. The acromion also provides attachment points for the deltoid muscle, which is a major muscle responsible for lifting and revolving the arm, as well as other muscles and ligaments that are involved in shoulder movement and stability. Different shapes of the acromion are associated with a variety of pathologies such as impingement syndrome and rotator cuff tear.[1]

Shoulder pain is a disabling symptom frequently encountered in patients of shoulder complaints. The estimated prevalence of shoulder complaints is 7–34%. One of the most common diagnosed shoulder disorder is Shoulder impingement syndrome(SIS) causing chronic shoulder pain. Its incidence ranges from 36% to 74% of patients of shoulder complaints.

In simple terms, SIS can be defined as a collection of shoulder symptoms and signs caused by pathology within the rotator cuff tendon itself (intrinsic) or structures external to it (extrinsic), causing impingement in the tapering space between the acromion and humeral head.[4] This syndrome, if left untreated, could result in rotator cuff disruption which then persists to cause secondary osteoarthritis of the shoulder, severely restricting shoulder movement in the end.[5]

As for now, there has not been a clear demonstration of SIS pathogenesis. There are 2 proposed mechanisms i.e intrinsic and extrinsic mechanism.[6] In the extrinsic mechanism, acromion is one of the structures involved in causing SAIS. Thus, the morphology and other parameters of the acromion are interesting to study. Dry bone measurement is more cost-effective when compared to imaging study. The variations of acromial morphology are different among races. Thus, it is important to study dry bone for the morphology of acromion in north Indian population and using it to correlate with SIS.

AIM

Aim of the study is to determine the morphology of acromion process of scapula in North Indian population and to find the association with subacromial impingement syndrome and rotator cuff pathology.

MATERIAL & METHODS

The material for the present study comprised of 100 adult scapulae of unknown sex, obtained from Department of Anatomy, Government Medical College, Amritsar. These scapulae were thoroughly cleaned and boiled. These non pathological scapulae were free from any physical deformity or abrasion and were complete in all respects i.e. the upper and the lower ends were intact, so as to give the correct measurements. They were labelled from 1-100 with suffix R (Right) or L (Left). Different morphological features were observed and morphometric measurements were taken. Both sides scapulae were inspected to describe anatomical morphology and data were recorded. The following parameters were studied:

1. Acromion process:

a) Shape of tip of acromion: whether cobra shaped, square shaped or intermediate type[8,9].
b) Acromial facet of acromioclavicular joint:
   i. Shape: oval or other.
   ii. Inclination: medially, vertically or laterally inclined[10,11].

Fig. 1

AB : vertical diameter of acromial facet

CD : transverse diameter of acromial facet

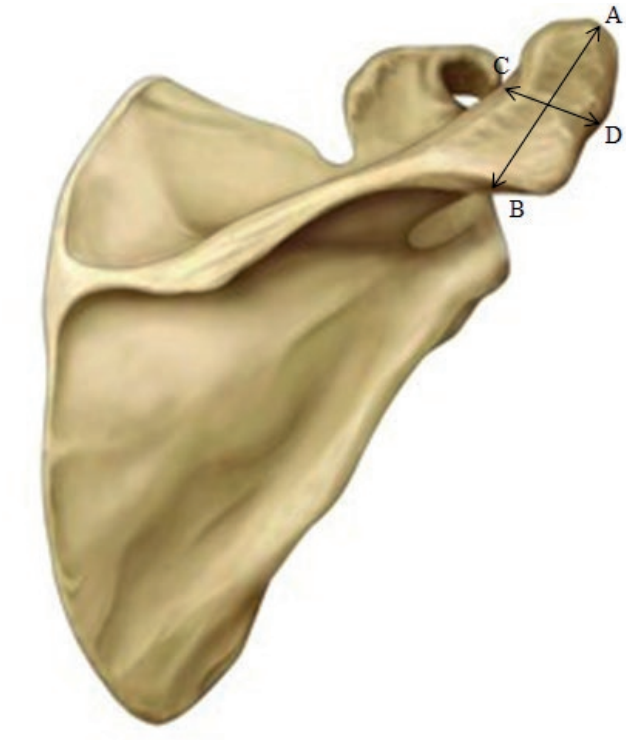

Fig 2

AB : maximum length of acromion process

CD : maximum breadth of acromion process

Fig. 3

AB : Maximum distance between acromion coracoid

AC : Maximum distance between acromion coracoid

iii. Vertical diameter: It was measured from mid-point of its upper border to that of the lower border with the help of vernier calipers (AB in Fig. 1).

iv. Transverse diameter: It was measured from its anterior end to the posterior end with the help of vernier calipers(CD in Fig. 1).

c) Inferior surface:

i. Rough / smooth: It was observed whether inferior surface was rough or smooth[10,11].

ii. Shape: Its shape was observed whether flat, curved, hooked or convex[10,11] and on the basis of shape of inferior surface, the acromion process was classified type I (flat), type II (curved), type III (hooked) or type IV (convex)[12,13].

iii. Enthesophytes (also called as acromion spur by Nicholson et al.)[18]: The acromion process was observed for presence or absence of enthesophytes[10].

d) Os acromiale : An attempt was made to find out os acromiale which is a clean, linear joint horizontal to the axis of acromion.

e) Maximum length: It was measured from the tip to the lower border of the crest of the spine in its mid sagittal plane[10,11] with the help of vernier calipers (AB in Fig. 2).

f) Maximum width: It was measured with the vernier calipers as the distance between the lateral and medial borders at the mid point of acromioclavicular ligament insertion[10,11] (CD in Fig. 2).

g) Anterior thickness: It was measured with the vernier calipers as the maximum thickness of the acromion[15,16].

h) Maximum distance acromion coracoid: It was measured with the vernier calipers as the distance between the tip of the acromion and the coracoid tip[14,15]. (AB in Fig.3) and between the tip of the acromion and mid point of lateral border of coracoid[12,17] (AC in Fig. 3).

RESULTS

1. Acromion process

a) Shape of tip of acromion : The most common shape of tip of acromion was found to be intermediate in 42(42%) bones whereas it was cobra shaped in 38 (38%) and square shaped in 20 (20%) bones. The incidence of intermediate type was equal for both right and left sides i.e 21 bones (21%). Cobra shape was more predominant on right side seen in 22 bones (44%) whereas square shape was more predominant on left side seen in 13 bones (26%) (Table 1).
b) Acromial facet of acromioclavicular joint
   i) Inclination of acromial facet : Out of the 93 bones having acromial facet, in 74 bones (79.60%) the facet was medially inclined. Incidence of medial inclination was much more on the right side 43(93.48%) as compared to the left side 31(65.96%). On the left side, vertical inclination is more prevalent [11(23.40%)] as compared with right side [1(2.17%)] (Table 1).
   ii) The mean vertical diameter of acromial facet for right and left side were 7.14mm (Range=4.35-11.67mm) and 7.24mm (Range=4.35-12.97mm) respectively (Table 2).
   iii) The mean transverse diameter of the facet for right and left side were 12.77mm (Range=16.68-29.98mm) and 12.74mm (Range=15.63-29.26mm) respectively (Table 2).
c) Inferior surface
   i) It was rough in 79 (79%) bones and smooth in 21 (21%) bones. The corresponding figures on the right side were 36 (52%) and 14 (28%); and on the left side were 43 (86%) and 7 (14%) for rough and smooth respectively (Table 1).
   ii) Out of the 100 bones of the present study, the shape/type was found to be curved in 43 (43%), flat in 31 (31%), convex in 15 (15%) and hooked in 11 (11%) bones. The commonest type was the curved on both right and left sides (Table 1).
   iii) Type II was the most observed type in 43% bones. Type I was next (31%), type IV (15%) and type III least common (11%) (Table 1).
   iv) Enthesophytes: the enthesophytes (also termed as acromial spur by Nicholson et al.)[18] were present in 16 (16%) bones out of 100 bones. Out of these, 10 (20%) bones belonged to the right side and 6 (12%) belonged to the left side. As far as association between the enthesophyte formation and type of acromion is concerned, out of the 16 bones with enthesophytes, 7 (43.75%) were of type II, 5 (31.25%) were of type III, 2 (12.5%) each were of type I and IV. Thus type II and III are more prone to enthesophyte formation.

   Neer[20] was the first to suggest that enthesophytes protrude into the subacromial space causing subacromial impingement and rotator cuff tears. These tears may be primary, initiated by intrinsic degenerative tendinopathy, and this incompetent cuff allows a proximal humeral migration with increased tension on the ligament that causes the growth of enthesophytes and impingement.

   Nicholson et al.[18] reported that traction spurs may develop over time, especially if an incompetent rotator cuff allows proximal humeral

Table 1. Comparison of morphology of acromion process in right and left side of scapula

Parameters		Right(n=50)	Left (n=50)	Total(n=100)
Shape(Tip of Acromion)	Cobra	22(44%)	16(32%)	38(38%)
	Square	7(14%)	13(26%)	20(20%)
	Intermediate	21(42%)	21(42%)	42(42%)
Inclination	Medial	43(93.48%)	31(65.96%)	74(79.60%)
	Vertical	1(2.17%)	11(23.40%)	12(12.90%)
	Lateral	2(4.35%)	5(10.64%)	7(7.53%)
Inferior surface	Rough	36 (52%)	43 (86%)	79 (79%)
	Smooth	14 (28%)	7 (14%)	21 (21%)
	Prevalence in type	TypeII (44.44%)	TypeII (46.51%)	TypeII (45.60%)
Shape/Type	Flat (type I)	13 (26%)	18 (36%)	31 (31%)
	Curved (type II)	21 (42%)	22 (44%)	43 (43%)
	Hooked (type III)	6 (12%)	5 (10%)	11 (11%)
	Convex (type IV)	10 (20%)	5 (10%)	15 (15%)

migration with increased contact on the ligament. These spurs may then contribute to impingement and may be a factor in continuing tendon wear and damage.

d) Os acromiale: although its existence has been reported by many authors, it was found to be absent in present bones.

e) The mean maximum length of acromion process observed was 44.10 mm (Range = 23.66-55.26 mm). On the right side, it was 45.57 mm (Range=23.78-54.61 mm) whereas on the left side, it was 42.64 mm (Range=23.66-55.26 mm). Thus it was higher on the right side than the left side (Table 2).

f) The mean width of acromion on the right side was 23.68mm (Range=16.68-29.98mm) whereas on the left side, it was 22.82mm (Range=15.63-29.26mm) (Table 2).

g) The mean anterior thickness of acromion on the right side was 7.41mm (Range=4.95-10.52mm) whereas on the left side, it was 7.04mm (Range=4.67-9.97mm) (Table 2).

h) The mean value of distance between tip of acromion and tip of coracoid on the right side was 38.56mm (Range=26.25-68.10mm) whereas on the left side, it was 38.15mm (Range=22.97-56.96mm). The mean value of distance between tip of acromion and lateral border of coracoid was 31.72mm (Range=15.82-59.36mm). On the right side, the value was observed to be 31.91mm (Range=22.17-59.36mm) whereas on the left side, it was 31.54mm (Range=15.82-47.14mm) (Table 2) .

DISCUSSION

The morphology of the acromion is assumed to be related to pathology of the rotator cuff and other shoulder impairments. Earlier Nicholson et al.[18] and Paraskevas et al.[10] have studied the inclination of acromial facet. While Nicholson et al.[18] found it to be almost equally distributed between 2 types (medial and vertical inclination), Paraskevas et al.[10] found medial inclination to be more prevalent. In our study, it was found to be more medially inclined (Table 3).

Earlier many authors have studied the shape of the inferior surface of the acromion. A vis a vis comparison with them has depicted that curved type is the most prevalent in almost all the studies done earlier in accordance with our study in which curved is found to be the most prevalent type (Table 4).

Neer[19] and Nicholson et al.[18] were of the opinion that the undersurface of the anterior 1/3 of the acromion is under the influence of coracoacromial ligament resulting in the formation of different acromial types. Wang et al.[20] are of the view that the acromial shape has a strong correlation with the severity of symptoms in impingement syndrome and it influences the outcome of conservative therapy. Natsis et al.[13] blamed hooked (Type III) acromions for shoulder impingement syndrome and rotator cuff tears. Farley et al.[22] confirmed this, but stressed that acromioplasty in patients with this type of acromion should include the mid portion of the acromion to achieve the anticipated decompression of the subacromial space. It is commonly accepted that rotator cuff lesions are noticed mainly in the hooked acro-

Table 2. Comparison of Morphometeric parameters of Acromion process in right and left side scapula.

Parameters		Mean (mm)		Range (mm)	
		Right (n=50)	Left (n=50)	Right	Left
Diameter of Acromial Facet	Vertical	7.19		4.35-12.97	
		7.14	7.24	4.35-11.67	4.35-12.97
	Transverse	12.75		15.63-29.98	
		12.77	12.74	16.68-29.98	15.63-29.26
Acromion Process	Width	23.25		15.63-29.26	
		23.68	22.82	16.68-29.98	15.63-29.26
	Length	44.10		23.66-55.26	
		45.57	42.64	23.78-54.61	23.66-55.26
	Anterior Thickness	7.23		4.67-10.52	
		7.41	7.04	4.95-10.52	4.67-9.97
Distance between tip of acromion and tip of coracoid		38.36		22.97-68.10	
		38.56	38.15	26.25-68.10	22.97-56.96
Distance Between tip of acromion and lateral border of coracoid		31.72		15.82-59.36	
		31.91	31.54	22.17-59.36	15.82-47.14

Table 3. Showing comparison of various parameters of Acromion process.

Author	Nicholson et al.[18]	Gallino et al.[16]	Paraskevas et al.[10]	Von Schroederet al.[12]	Piyawinijwong et al.[14]	Coskun et al.[8]	Present Study	
							Right	Left
Population (n)	American (396)	Egyptian (266)	Greek (88)	Canadian (30)	Thai(97)	Turkish (90)	North Indian (100)	
Shape of tip						C S I	C S I	
						28(31%) 12(13%) 50(56%)	38(38%) 20(20%)	42(42%)
							22(44%) 16(32%) 7(14%) 13(26%)	21(42%) 21(42%)
Inclination of acromial facet	M V L		M V L				M V L	
	49 48 3		46 38 4				74 12 7	
							43 31 1 11	2 5
Length	44.55	41.5	46.1	48.0	40.0	44.7	44.1	
							45.57	42.64
Breadth	18.95		22.3	21.9	23.9		23.25	
							23.68	22.82
Anterior thickness	7.2	6.9	8.8	9.4	6.4		7.23	
							7.41	7.04
Maximum distance between tip of acromion and tip of coracoid		27.4			29.5		38.36	
							38.56	38.15
Maximum distance between tip of acromion and lateral border of coracoid		28.1	27.1				31.72	
							31.91	31.54

Table 4. Showing comparison of shape and type of inferior surface of acromion.

Author	Race (n)	Shape/Type			
		Flat (I)	Curved (II)	Hooked (III)	Convex (IV)
Nicholson et al18	American(396)	127 (32%)	165 (42%)	104 (26%)	-
Gallino et al16	Egyptian(233)	48(20.6%)	169(72.5%)	16 (6.9%)	-
Gumina et al19	Italian(204)	45%	34%	21%	-
Von Schroeder et al11	Canadian(30)	23%	63%	14%	-
Coskun et al8	Turkish(90)	9 (10%)	66 (73%)	15 (17%)	-
Natsis et al13	German(423)	51 (32%)	239(56.5%)	122(28.8%)	11 (2.6%)
Paraskevas et al10	Greek(88)	23 (26.1%)	49 (55.6%)	16 (18.1%)	-
Present study	North Indian(100)	13 (26%)	21 (42%)	6 (12%)	10 (20%)
		18 (36%)	22 (44%)	5 (10%)	5 (10%)
		31 (31%)	43 (43%)	11 (11%)	15 (15%)

mion. Nicholson et al.[18] explained this correlation by the reduction in the dimensions of the subacromial space in the hooked acromion, which more often leads to impingement of the rotator cuff. However, they lamented that it is still open to question whether the hooked shape is a congenital feature or represents a degenerative change by which type I is converted to type III in the course of time.

Out of the 100 bones of the present study, when compared on both the sides, the length was more on right side as compared to the left side. On comparing both the sides, the mean width was more on the right side as compared to the left side. An increased length of acromion limits the overhead activities and is closely associated with degenerative changes. Similarly, increased dimensions are useful for supporting screw, pin or wire for fracture stabilization of acromioclavicular joint or arthrodesis of shoulder joint[23]. There was negligible difference in the values of vertical and transverse diameter of the facet of the two sides. Our values were less than those found by Nicholson et al.[18]. The acromion was wider on the right side than on the left side. Acromial shape and dimensions are of particular importance in acromioplasty for rotator cuff impingement syndrome[19]. Earlier Nicholson et al.[18], and Paraskevas et al.[10] have measured this parameter in different populations. When we compare their results with the present study, it is evident that our values were near to those of in their population. The values for the right side were more than the left side (Table 3). When we compare our study with Paraskevas et al.[10], our value was higher than those found by them. We observed that the mean value of distance tip of acromion between tip of coracoid and lateral border of coracoid was more on the right side than on the left side. Neer[19] cautioned against excessive resection while doing acromioplasty in open surgery in the races with thin acromion. It is further stressed by some authors that such precautions should also be exercised in the arthroscopic version of acromioplasty, which may not allow a precise estimate of the amount of resected acromion.

CONCLUSION

To conclude, it can be said that these findings of the present study abide by the results of previous authors but a racial variation was also observed in various dimensions. The majority of the parameters were observed to be higher on the right side than the left side. The differences between the present study and the other studies in these morphometric parameters show that there are racial and regional variations. This knowledge will be helpful for the orthopedicians in diagnosing and planning treatment procedures for patients with impingement syndrome and rotator cuff pathology.

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