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Original Article

Anatomy Section

Morphometric Anatomy of Acromion Process: An Observational Study

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ABSTRACT

Introduction: The acromion process is the elongated and flattened process of scapular spine. The scapular morphometry is an important factor related to impingement syndrome of the shoulder joint. Acromion process is classified according to the standard Bigliani's classification into Type I, II and III.

Aim: The aim of the study is to correlate the variations of acromion anatomy in orthopedic surgery of the shoulder joint.

Materials and Methods: This was an observational study conducted on 297 adult human scapulae (145 rights and 152 left) of unknown age and sex. Length, breadth and thickness of the acromion process were measured with by Vernier caliper. The distances were measured from the tip of the acromion process to the supra glenoid tubercle and to the tip of the corocoid process.

Results: The acromion process was classified into Type 1 (flat) Type 2 (curved) Type 3 (hooked) as per the surface curvature. The average length, breadth and thickness of acromion process on the right and left scapulae were 41.72±5.20 mm, 21.42±3.06 mm, 6.68±1.76 mm and 38.97±4.81 mm, 21.57±2.73 mm, 6.59±1.67 mm respectively. The acromio-coracoid distance, acromio-glenoid distance, height of coraco-acromial arch and angle of acromial inclination in degrees on the right and left side were 37.49±4.87 mm, 26.39±2.64 mm, 21.01±4.06 mm, 43.2±5.94° and 37.23±4.48 mm, 24.20±3.14 mm, 19.52±3.00 mm, 54.86±7.36° respectively.

Conclusion: Various anatomical measurements of acromion process will guide the orthopaedic surgeons during shoulder joint surgery and also reveals possible evolutionary changes during the adoption of bipedal gait in human beings in anthropology.

Keywords: Anthropology, Bigliani classification, Corocoid process, Impingement syndrome

INTRODUCTION

The scapula is a large, flat and triangular bone which lies on the posterolateral aspect of the chest wall extending from 2nd to 7th rib. The elongated and flattened process of scapular spine is known as acromion process. It is present in the upper lateral end of scapula constituting an important component of coraco-acromial arch.

The lateral end of coraco-acromial ligament is attached to the tip of the acromion process. Coraco-acromial apparatus constitutes the anterior third of acromion process, the coracoid process and the coraco-acromial ligament. The rotator cuff tendons, the sub-acromial bursa, the biceps tendon and head of humerus are passing beneath the arch in a narrow space. The shoulder impingement syndrome can be produced by any condition limiting the narrow space available underneath the coraco-acromial arch may be developmental or congenital [1]. Acromion process is classified into Type I or flat, Type II or curved, and Type III or hooked. We considered the Bigliani-Morrison-April morphological classification as a diagnostic tool for the shoulder impingement syndrome and rotator cuff injury [2]. The most common theory for the impingement syndrome of the rotator cuff muscles is classified into anatomical and functional. The shape and inclination of the acromion process is responsible for most of the shoulder complaints and seen highest with Type III acromia [3]. Rotator cuff lesions are usually associated with the hooked Type of acromion process [4]. The glenoid cavity may be classified as per a notch on the anterior glenoid rim into pear shaped, inverted comma shaped or oval [5]. The glenoidal inclination is very often seen in rotator cuff injury and its size and shape is important for the understanding of shoulder dislocation and rotator cuff injuries. About (62-66%) of the cases of rotator cuff rupture involve the Type III acromion [4]. It is also important to assume the size of the glenoid component in the shoulder arthroplasty as well as gleno-humeral osteoarthritis [6].The variations of acromial morphology is developmental as well as age related changes due to spur formation. Hence, both of them are contributing to impingement syndrome and should be kept in mind during surgery around the shoulder joint [7]. The scapula is one of

the important bone for research because of its phylogenic, ontogenic and racial variations. It helps anthropologists during their study on evolution of acromion process [8]. The aim of the present study is to collect and compare the various measurements of acromion process with similar studies in India and abroad.

MATERIALS AND METHODS

This observational study was conducted in the Post Graduate Department of Anatomy, SCB Medical Collage Hospital, Cuttack, India between the months of April to August 2017. All the scapulae in good condition with intact acromion process were included in the study and the scapulae with breaks and fragmented were excluded from the study. Total 297 ossified dry unbroken scapulae of unknown age and sex were considered in the study. Out of 297 scapulae 145 belongs to right side and 152 left to side. The linear distances were taken by a sliding vernier caliper in millimeters upto 0.1 mm accuracy. The angular measurements were done by using goniometer.

Various parameters related to acromion process were measured with the help of a vernier caliper and goniometer as follows.

- The length of acromion process in millimeters is the longitudinal distance between the tips of acromion process to midpoint of its posterior border.
- The breadth of acromion process in millimeters is the horizontal distance between the midpoints of anteromedial and postero lateral borders.
- The thickness of acromion in millimeters is the vertical distance between the superior and inferior surfaces at midpoints of anteromedial and posterolateral borders.
- The coraco-acromial distance in millimeters is taken as the distance between tip of corocoid process to tip of acromion process
- The acromio-glenoidal distance in millimeters is taken from the tip of acromion process to supraglenoid tubercle.
- The height of the coracoacromial arch is the distance between supra glenoid tubercle to a line joining the tip of acromion process to the tip of corocoid process.
- The acromial inclination of acromion process is taken as the angle in degrees in its vertical axis.

Ethical issues: The present study satisfies the ethical principles of medical research mentioned in World Medical Association Declaration of Helsinki. Ethical clearance was given by the Institunal Ethics Committee (IEC) S.C.B Medical College Cuttack, 753007, Orissa.

STATISTICAL ANALYSIS

All data obtained were analysed using the GraphPad program Windows (GraphPad Software). Statistical significance was accepted when p-value is ≤ 0.05.

RESULTS

The curved acromions were observed 84 (57.93%) in right side, 85 (55.93%) in left side and total 169 (56.90%) in both the sides. The flat acromion processes were second highest occurring 38 (26.21%) in right side, 38 (25%) in left side and the total being 76 (25.59%). The hooked acromions were least common and found 23 (15.86%) in right side, 29 (19.07%) in left side and 52 (17.51%) in both the sides of the study group [Table/Fig-1,2]. It was observed that the mean length of right acromion process was 41.72±5.20 range 30.6 mm to 51.31 mm and left was 38.97±4.81 range 29.2 to 46.6 mm. The length of right acromion process was longer than left by 2.75 mm ($p<0.0001$and $t < 4.734$). The mean value of breadth was being 21.42±3.06 (range 14.2 mm to 27.27 mm) in right acromia in comparison to 21.57±2.73 ranges (16.4 mm to 29.7 mm) in left side. The left acromion was 0.15 mm broader than the right with ($p<0.6558$ and $t <0.4462$).The thickness of right acromion was 6.68±1.76 ranges (4.2 mm to 10.02 mm) and left was 6.59±1.67 ranges (4 mm to 10.01 mm). The right side was 0.9 mm thicker than left ($p<0.6475$ and $t <0.4575$) [Table/Fig-3]. The breadth and thickness was slightly higher in left side than right. The acromio-coracoid distance on the right and left side were varied from 26 to 47.6 mm with the mean value 37.49 ± 4.87 mm and 26.6 to 49.5 mm with the mean 37.23 ± 4.48 mm respectively. It had been observed that there were no statistically differences between right and left side ($t = 0.479$, $p < 0.632$). Similarly, the mean acromio-glenoid distance was found to be 26.39±2.64

[Table/Fig-1]: Showing three types of acromion procces: a) Flat; b) Curve; and c) Hooked.

Type	Curvature	Right	Percent	Left	Percent	Both	Percent
Type I	Flat	38	26.21%	38	25%	76	25.59%
Type II	Curved	84	57.93%	85	55.93%	169	56.90%
Type III	Hooked	23	15.86%	29	19.07%	52	17.51%
Total	297	145	100%	152	100%	297	100%

[Table/Fig-2]: Type of the acromion process of scapula.

Parameters (in mm)	Right n=145			Left n=152			Both n=297	
	Mean±SD	Min (mm)	Max (mm)	Mean±SD	Min (mm)	Max (mm)	p-value	t-value
Length	41.72±5.20	30.6	51.31	38.97±4.81	29.2	46.6	0.0001	4.734
Breadth	21.42±3.06	14.2	27.27	21.57±2.73	16.4	29.7	0.6558	0.4462
Thickness	6.68±1.76	4.2	10.02	6.59±1.67	4	10.01	0.6476	0.4575

[Table/Fig-3]: Statistical measurements of the dimensions of the acromion process.

Parameters	Right n= 145			Left n=152			p & t value	
	Mean±SD	Min	Max	Mean±SD	Min	Max	p-value	t-value
Acromio coracoid distance (in mm)	37.49±4.87	26	47.6	37.23±4.48	26.6	49.5	<0.632	0.479
Acromioglenoid distance (in mm)	26.39±2.64	22.22	33.67	24.20±3.14	19	29.5	<0.0001	6.490
Height of the coraco-acromial arch (in mm)	21.01±4.06	16.7	26.51	19.52±3.00	12.1	25.38	<0.0004	3.308
Acromial inclination (in degrees)	43.2±5.94	31	60	54.86±7.36	30	61	<0.0001	14.981

[Table/Fig-4]: Statistical measurements of the acromion distances.

ranges 22.22 to 33.67 mm and 24.20 ± 3.14 mm on right and left side respectively with (p<0.0001 and t= 6.490), which was statistically significant. The height of the coraco-acromial arch had the mean value of 21.01±4.06 ranges 16.7 to 26.51 mm on right side and 19.52±3.00 ranges 12.1 to 25.38 mm on the left side with statistically significant (p<0.0004 and t=3.308) values [Table/Fig-4,5]. The inclination of acromion process in relation to the vertical axis of scapula was showed the mean value as 43.2±5.94 ranges 31 to 60 degrees on right side and 54.86±7.36 ranges 30 to 61 degrees in left side respectively with statistically significant (p<0.0001 and t=14.981) values [Table/Fig-4,6].

[Table/Fig-5]: Showing height of the coraco-acromial arch and acromio-coracoid distance. **[Table/Fig-6]:** Acromial inclination in degrees in relation to the vertical axis of scapula.

DISCUSSIONS

In the present study the dimension of the subacromial space is considered, which forms the basis of subacromial impingement and shoulder joint pathology. Anatomical components like the shape and inclination of the acromion are considered to be the contributing factors for the impingement syndrome of the rotator cuff muscles [1]. Quite a good number of studies have been carried out on the morphometry of the acromion process of the scapulae. The acromial morphology is well documented for shoulder impingement and rotator cuff tears. Biglinani LU et al., classified three main types of acromion i.e., Type-I (flat), Type-II (curved) and Type-III (hooked). The least common hooked type of acromion process had closely related to the subacromial impingement syndrome and rotator cuff tear [2]. We observed maximum number of Type II (curved acromia) in169 (56.90%) out of 297 specimens. The Type I (flat acromion processes) were the second highest occurring 76 (25.59%) of specimens followed by the Type III (Hooked acromions) were least common and found in 52 (17.51%) of the observed group. Our study corroborates the study of Coskun N et al., Nicholson GP et al., and the percentage satisfies the Bigliani-Morrison-April classification of Type I (6-32%, Type II (42-69%) and Type III (8.6-39%) [Table/Fig-7] [6,8-10]. The thickness of acromion was observed as 6.68 mm in the present study which was similar to the study in Indian population by Singh J et al., [8].

In comparison of right and left side the breadth and thickness are similar with statistically insignificant value but length of right acromion processes are longer than left by 2.75 mm with (p<0.0001and t < 4.734) which is statistically significant and almost similar to most of the earlier studies [11]. The acromio-coracoid distance, acromio-glenoid distances and height of cora-coacromial arch are similar to other studies in India and Nepal [8,12]. Acromio-glenoid distances and height of the coraco-acromial arch between both sides showed significant difference probably due to the higher mobility of right hand over left in right handed persons. The Inclination of the acromion in the present study was 43.2°± 5.94° on the right side 54.86 °±7.36° on the left side respectively. The slope of acromion (inclination) is associated with degenerative changes as well as impingement syndrome [13]. The more horizontal is the acromion (angle >35°) the greater is the impaction and degeneration.The acromial inclination angles more than 41° are rarely complicated with shoulder impingement [14]. Hence the degree of acromial inclination was directly proportional to the shoulder impingement syndrome [15]. The space below the coraco-acromial arch may compress the anatomical structures passing below it due to the variation in curvature changes of acromion process [16]. The incidence of rotator cuff tears to be most closely associated with Type III acromia.

Author	Year	Population	No	Type I	Type II	Type III
Nicholson GP et al., [6]	1996	North America	420	32%	42%	26%
Singh J et al., [8]	2013	Indian	129	29 (22.5%)	50 (38.8%)	50 (38.8 %)
Coskun N et al., [9]	2006	Turkish	90	9 (10%)	66 (73%)	15 (17%)
Getz JD et al., [10]	1996	Greece	423	22.8%	68.5%	8.6%
Present study	2017	Indian	297	25.59%	56.90%	17.51%

[Table/Fig-7]: Comparison of type of the acromion process of scapula with previous studies.

The morphometric variations of the distances compromise the space below the coraco-acromial arch and causing lesions of the anatomical structures present in this region [17].

LIMITATION

The age and sex of the bones were not studied as it is not available.

CONCLUSION

The shoulder impingement syndrome is directly related to the degree of inclination of the acromion process.The subacromial space below the coraco-acromial arch is highly compromised due to the variation in different curvatures related to the acromion process. Our study results have clinical implementations to understand the mechanisms of sub-acromial shoulder joint derangements and a guide to orthopedic surgeon during shoulder replacement and rotator cuff repair. The above data will also be helpful to the anthropologists while studying about the evolution of the bipedal gait.

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