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Original Research Article

MORPHOLOGICAL VARIATIONS OF GLENOID CAVITY OF HUMAN SCAPULAE: AN ANATOMICAL STUDY WITH CLINICAL RELEVANCE

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ABSTRACT

Purpose: The purpose of this present study was to observe the morphological variations of glenoid process of adult human scapulae by subjective evaluation, because morphologic variants of adult glenoid process play an important role in various shoulder joint pathologies especially dislocations with fractures of the glenoid cavity which is also quite common.

Materialsand Methods: Two hundred sixty adult dry scapulae (127 right & 133 left) from the osteology museum of department of Anatomy, belonging to Indian population of unknown sex & age were obtained for the morphologic pattern of glenoid cavity by subjective evaluation. We have examined the presence of notch in the glenoid process of each scapulae& according to the presence of notch, we evaluated the bones for the morphological classification as pear; inverted comma & oval shaped glenoid process. Our observations were compared with other osteological studies performed on different other population groups.

Results: Out of total 260 scapulae, 187 bones showed notch in the margin of the glenoid cavity.Most of the bones without a notch were termed as oval shaped (73 scapulae) glenoid & rest of the bones were of pear shaped variety. Among the pear shaped glenoid, 113 scapulae showed pear shaped cavity with slight notch; 71 scapulae showed an inverted comma shaped glenoid. Not only the basic morphology, we have also reported some of the scapulae with special morphologic features like a very prominent infraglenoid tubercle; presence of foramen in the glenoid cavity &highly special nodular glenoid cavity.

Conclusions: Though glenoid cavities showed highly variable morphological pictures, but the clinicians should be well versed with the normal appearance & anatomic variants of glenoid cavities on dry bones, so that they can interpret its morphology on radiographs and MRI scans. Our results of this subjective evaluation may be of help as baseline data for theclinicians especially for the orthopaedic surgeons for the diagnosis &treatment modalities of shoulder dislocations & fracture.

KEY WORDS: Glenoid Cavity, Morphology, Notches, Shoulder Dislocation, Subjective Evaluation, Anatomic Variants.

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INTRODUCTION

The scapula; known as the shoulder blade whichlies on the posterolateral aspect of the chestwall; articulates with the distal end of clavicle & humeral head at the glenohumeral joint[1]. Anatomical considerations are central in understanding specific abnormalities such as rotator cuff injuries & glenohumeral dislocations [2]. On the lateral angle of the scapula bears a piriform shallow articular surface known as

glenoid fossa or glenoid cavity of the scapularegarded as the head of the scapula [3]. The surface of the glenoid cavity surface is covered with hyalinecartilage and its margins slightly raised which give attachment tothe glenoid labrum [4]. The glenoidal labrum is a fibrocartilaginousstructure which deepens thecavity.This fibrocartilaginousstructure actually forms the of this glenoid notch [5].

The glenohumeral joint is most unstable jointin the body due to its performance of a widerange of movements. Dynamic factors of therotator cuff muscles and the static factors of theglenohumeral ligaments, the labrum and thejoint capsule play a role in glenohumeral jointstability [6,7].The vertical diameter of the glenoid fossa is the longest & it is wider below than above [3]. This is the part that actually articulates with humeral head to form shoulder joint. Dislocations with fractures of the glenoid are also quite common while trauma. So, not only repairment of the glenoid labrum with capsular reinforcement but also total shoulder replacement is being used as a part of the treatment [7]. Detailed & well verged knowledge of the shape & dimensions of the glenoid are important in total shoulder arthroplasty [2]. So, an understanding of the variations regarding normal anatomy of glenoid is essential while evaluating different shoulder pathology [3].Morphology of the glenoid cavity is highly variable but the shape of the glenoid cavity has been described by most of the standard anatomical textbooks as pear shaped; rounded& ovalor inverted comma shaped [8]. Glenoid cavity having a notch at the anterior margin or just above middle of the anterior margin of the cavity which can be very prominent or very shallow or might be absent also. Due to the presence of this glenoid notch, various shapes of the glenoid cavity are found [5,9].Though the glenoid cavity is shallow & disproportionate sizes of the head of the humerus combined with a lax articular capsule give a wide range of movements but the joint becomes unstable & most commonly dislocated joint [10].

Proper functioning of the rotator cuff muscles & joint capsule, glenoid labrum as well as glenohumeral ligaments play the most important role in maintaining the stability of the joint [7].

Normal anatomy & variations regarding glenoid cavity are the prerequisites for complete understanding of the shoulder joint mechanics as well as rotator cuff tear management & glenohumeral instability [11, 12].Therefore complete knowledge of the shoulder joint is obtained only when glenoid morphology will be studied in detail. So, It is expected that, the data of morphological evaluation of glenoid cavity of scapulae will serve as a reference base for the Indian population which will be helpful for the clinicians especially orthopaedic surgeons for proper diagnosis & treatment of different shoulder pathologies.

MATERIALS AND METHODS

Subjective evaluation (Visual inspection) was done on 260 adult dry scapulae obtained from the osteology museum belonging to adult Indian population of unknown sex were evaluated for morphologic pattern of glenoid cavity. We have examined the presence of notch in the glenoid process of each scapulae like Prescher et al. [5]& segregated them. Then according to the presence of notch, we evaluated the bones for the morphological classification. We classified them as pear shaped with a slight notch; pear shaped with distinct notch that is inverted comma appearance & last is the oval glenoid process. Meta analysis was also performed by comparing our results with the results of other scholar's valuable work. Apart from the morphological pattern of glenoid cavity, any other special features regarding the glenoid cavity was also recorded.

To test the association, statistical analysis as chi square test was applied.

RESULTS

Table 1: frequency distribution of glenoid notch in relation to sides of the scapulae.

Side of scapulae	Notch present		Notch absent	
	n	%	N	%
Right (127)	86	67.7	41	32.28
Left (133)	101	75.9	32	24
Total (260)	187		73	

For statistical analysis [13] Pearson's Chi-squared test applied & it showed Chi-squared = 2.1755, df = 1, Pvalue = 0.1402

Of the 260 scapulae studied, 127 belonged to right side and 133 belonged to left side. By

visual inspection method we have obtained the following results: among these 260 bones, 187 bonesshows notch in the margin of the glenoid cavity; 86 bones were of right side & 101 bones were of left side. This result has been shown in Table 1.

According to the presence of notch, we have observed two types of glenoid cavity; pear shaped & oval glenoid. Most of the bones with notch were of pear shaped & rest of the bones were mostly oval. So, the prevalence of pear shaped bones in our study were of 184 (70.76%)& oval shaped bones comes 76 (29.23%). Because 73 bones shows absence of notch should be oval shaped but 3 more bones were of oval shaped with slight notch. Of these 184 pear shaped bones, 113 bones (51 bones of right side & 62 of left side) were truly pear shaped with just slight notch in the margin of the glenoid show notch; 71 bones (34 bones of right side & 37 bones of left side) were of inverted comma shaped because they showed a well distinct notch in the glenoid margin. Among the 76 oval shaped glenoid, 42 bones were of right side & 34 of left sided scapulae. This result has been shown in Table 2.

Table 2:frequency distribution of glenoid morphology among right& left sided scapulae.

Shape of glenoid cavity	Side of scapula				Total (260)
	Right (127)		Left (133)		
	n	%	n	%	n
Pear shaped with very slight notch	51	40.15	62	46.61	113
Pear shaped with with distinct notch (inverted comma)	34	26.77	37	27.81	71
Oval shaped	42(41+1)	33.07	34(32+2)	25.56	76

In Pearson's Chi-squared test[13]Chi-square = 1.9022, df = 2, p-value = 0.3863.

Fig. 1: A) Lateral view of scapula showing a pear shaped glenoid cavity; B) lateral view of scapula displaying an inverted comma shaped glenoid cavity; C) lateral view of scapula showing a oval shaped glenoid without notch.

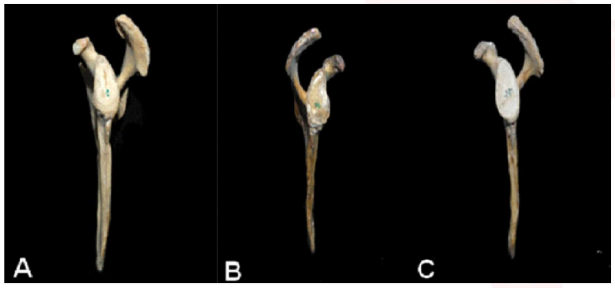
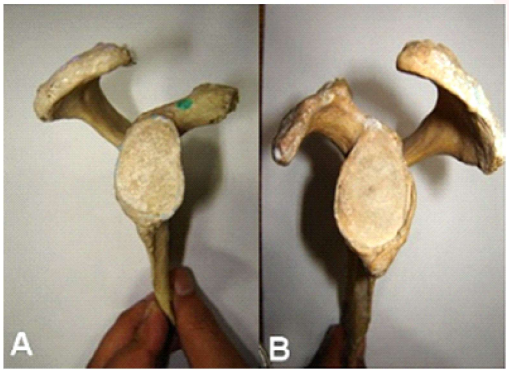
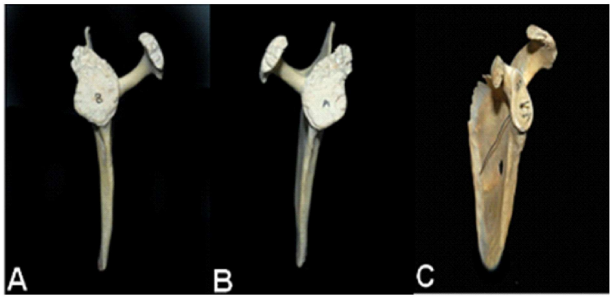


Fig. 2: A) scapula exhibiting oval shaped glenoid cavity with notch; B) oval shaped glenoid with a big infraglenoid tubercle.



Apart from the three different shaped glenoid cavity in the scapulae, we have also obtained glenoid cavity with large infraglenoid tubercle in 4 scapulae (1.5%); a single round shaped foramen in the centre of the glenoid fossa in 3 (1.1%) glenoid cavity which has been shown in the Fig 3(C) with the help of a probe. Not only different shaped glenoid cavity, there were two scapulae (0.7%) which showed pear shaped glenoid fossa with multiple small rounded elevations as nodular appearance well as incomplete formation of acromion process in Fig 3 (A, B).

Fig. 3: A, B) two scapulae showing pear shaped glenoid cavity with nodular appearance along with incomplete formation of acromion process; C) scapula showing a foramen in the pear shaped glenoid cavity in which the probe has been passed.



DISCUSSION

The morphological variations are very commonly seen in the glenoid cavity which is regarded as the head of the scapula and articulates with the

Table 3: Distribution of glenoid morphology among dry bones in different population group.

Authors (year)	Population group	Total no of bones	Bones in right & left side	Shape of glenoid cavity		
				Pear (%)	inverted comma (%)	oval (%)
Prescher et al. (1997)	Germany	236		55		45
Coskun et al. (2006)	Turkish	90		28		72
Mamatha et al. (2011)	Mangalore (south India)	202	Right - 98	46	34	20
			Left - 104	43	33	24
Rajput et al. (2012)	Baroda, India	100	Right - 43	49	35	16
			Left - 57	46	39	15
kavita et al. (2013)	Rajasthan, India	129	Right - 67	58	11	30
			Left - 62			
Gosavi et al. (2014)	Pune, India	142	Right - 62	54	12	32
			Left - 80	45	11	43
Gursharan et al. (2014)	Punjab, India	80	Right - 41	48	29	21
			Left - 39	46	35	17
Neeta et al. (2015)	New Delhi, India	126	Right - 55	47	22	31
			Left - 71	55	13	32
Rajendra G K et al. (2016)	Maharashtra	200		56	35	7
Vaishnani et al. (2018)	Gujarat, India	74	Right – 36	44	17	38
			Left - 38	47	18	34
Saha et al. (2019)	Delhi , Gurugram, India	260	Right - 127	40	27	33
			Left - 133	47	28	26

head of the humerus at the glenohumeral joint[14]. Morphological variants of the glenoid like alterations in size, shape or any projections are associated with functional muscle-bone unit& may affect glenohumeral instability [15]. So,anatomical considerations have enormous importance for the orthopaedic surgeons & prosthetic designers [2]. The presence of the notch in the anterior margin part of the glenoid rim has a great role to determine the morphology of glenoid cavity [5, 8]. The shoulder joint is not only one of the most frequently dislocated joint of the body but also dislocation along with the fracture of glenoid cavity which is quite common[3,10]. So, management of rotator cuff injuries, fractures, dislocations mostly needed prosthesis & arthroplasty [2]. Any kind of implant for shoulder joint or prosthesis or surgical interventions depend on the anatomical basis & variations of morphology of the glenoid cavity of scapula which is of a fundamental importance [12]. Maman et al. [15] in 2008 analyzed 200 dry scapulae in Brazilian population & observed different morphological groups of glenoid cavity among the scapulae. They concluded35.5% scapulae in group 1 which showed very evident glenoid incisures in the anterior margin with, tined superior pole and wide inferior pole. The secondgroup 23.5%, were characterized by less evident glenoid incisure with tined superior pole and wide inferior pole. The third group 21.5%, represented by articular faces with a glenoid inscisure in its anterior margin. The last fourth group19.5%, exhibited by is characterized by an anterior margins without glenoid incisure and an ellipsoid-shaped glenoid cavity were determined.

Though glenoid cavity showed variable morphology, but two researchers had reported only pear shaped & oval glenoid fossa in the scapulae among German & Turkish population respectively [16, 5]. Rest of the research studies reported three types (pear; inverted & oval shaped) of glenoid cavity. Some of the authors Kavita et al [17]. &Gosavi et al. [18] noticed a very less inverted comma shaped glenoid cavity among Indian population as compared to pear & oval

shaped. Most of the studies showed a higher incidence of pear shaped glenoid cavity & a very lower incidence of oval shaped glenoid cavity like Rajput et al. [19], Rajendra et al. [20]&Gursharan et al. [21]. All these previous studies were conducted in Indian population. But in our present study of 260 dry scapulae, the highest incidence of pear shaped glenoid cavity were observed which was almost 40 % in the right scapulae & 47 % in the left scapulae; next was oval shaped glenoid & then inverted comma shaped appearance. So, our results are in consonance with the studies performed by Neeta et al. [11]in North Indians andVaishnani et al. [14] in Gujarati population.But to the best of our knowledge, our study conducted on the highest number of dry bones that is 260 scapulae. Apart from that, like Prescher et al. [5] we have also applied the same method to determine the shape of the glenoid process.So, it is expected that, the authentication of our results will be high as compared to other studies. Glenoid cavity having a large infraglenoid tubercle in 4 scapulae (1.5%). Among these 260 scapulae, we have also observed single round shaped foramen in the centre of the glenoid fossa in 3 (1.1%) glenoid cavity which has been shown in the Fig 3(C) with the help of a probe. Not only different shaped glenoid cavity, there were two scapulae (0.7%) which showed pear shaped glenoid fossa with multiple small rounded elevations as nodular appearance well as incomplete formation of acromion process as shown in Fig 3(A,B). To the best of our knowledge, no previous studies have been reported this type of nodular morphologic pattern of the glenoid cavity of the scapula.

CONCLUSION

The morphologic data on variable shape of glenoid process bears a vital role in shoulder dislocation & placement of prosthesis. Our results will provide an anatomical baseline to correlate the radiologic findings with clinical presentations. This data will facilitate to the orthopaedic surgeon to devise appropriate operative strategy, so that the functionality of the shoulder joint can be restored.

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Conflicts of Interests: **None**

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