Egyptian Journal of Anatomy, Jul. 2017; 40(2):301-322

Original Article

Anatomical Variations of the Scapula in Adult Egyptian Population and their Clinical Implication: Morphological and Morphometric Study on Dry Bone and Radiograph

Mohamed Emad, Sherif Fahmy, Shereen Abdel Fattah, Ebtehal Hasan

Department of Anatomy and Embryology, Faculty of Medicine, Cairo University

ABSTRACT

Background: Knowledge of the normal anatomy and the possible variations of the scapula are beneficial in early diagnosis and proper management of shoulder disorders to evade its disabling complications as well as to avoid injury of the important neurovascular structures around the scapula.

Aim of work: To estimate the prevalence of the anatomical variations of the scapula and their clinical implications and to calculate the acromion index and acromio-humeral interval; which could be helpful in the management of rotator cuff diseases.

Material and Methods: One hundred dried scapulae were studied for morphological and morphometric variations. A radiological study was done by calculating both acromion index and acromio humeral interval in one hundred radiographs.

Results: Four types of acromion were observed: type-1(flat), type-2(curved), type-3 (hooked) and type-4 (convex downwards). Four shapes of acromion were identified: cobra-head, triangular, rectangular and square. Acromion thickness ranged from 5 to 11mm.Acromion length ranged from 24 to 65mm.Acromion width ranged from 18 to 40mm.Acromio-glenoid distance (AGD) ranged from 20 to 40mm.Acromio-coracoid distance ranged from 22 to 68mm. Suprascapular notch shapes included U-shaped, V-shaped, J-shaped and W-shaped notch that was encountered for the first time in literature. Suprascapular notch types were: type-1 (absent notch), type-2 (wide and shallow notch), type-3 (narrow and deep notch), type-4 (a bony foramen) and Type-5 (a notch is present above a bony foramen). Anatomical variations causing snapping scapula were lushka tubercle and teres major process. Acromion index (AI) ranged from 0.63 to 0.71. Acromio-humeral interval (AHI) ranged from 7 to 14mm.

Conclusion: The anatomical variations of the scapula should be considered by orthopaedicians, as it influences the technique and instrumentation in open or arthroscopic surgical procedures.

Key Words: .dry bone, Egyptian population, morphometry, radiograph, scapula

Corresponding Author: Shereen Abdel Fattah, *Department of Anatomy and Embryology, Faculty of Medicine, Cairo University,* **Email:** dr_shery.fattah@yahoo.com, **Mobile:** .01099060936

INTRODUCTION

The scapula is an integral part of the connection between the upper extremity and the axial skeleton *(Gupta et al., 2015)*. Anatomical variations of the scapula have been studied among different populations *(Kharay et al., 2016)*, including the acromion process, coracoid process and suprascapular region, in addition to its borders and angles *(Singh et al., 2013)*.

Different shapes of the acromion process have been described in literature including cobra-head (tubular) which is the commonest shape among Turkish (31%) *(Coskun et al., 2006)*, quadrangular that is prevalent in Nepalese (52.94%) *(Mansur et al., 2012)*. While the triangular widest acromion is the prevailing shape among Egyptians (53.12%) *(Nasr El Din and Ali, 2015)*.

Bigliani et al. (1991) classified the acromion into to 3 types: type1 (flat), type2 (curved) and type3 (hooked), the incidence of each acromion type varied widely among different populations. *Aragao et al.* (2014) reported a significant relationship between hooked acromion and rotator cuff tears (RCT). He added that Individuals having hooked acromion have more propensities towards subacromial impingement (SAIS) than those having other types; this is because of subacromial stenosis. Acromion variation

 DOI: 10.21608/EJANA.2018.16908

should be considered by orthopaedicians, since it influences the technique and instrumentation plan in open or arthroscopic surgical procedures *(Adolfsson, 2015)*.

The suprascapular notch (SSN) is one of the highly variable and clinically important parts of the scapula (*Fatima et al., 2015)*. In the hierarchy of the possible etiologic factors for suprascapular nerve entrapment syndrome (SNES), the anatomical variations of the SSN and the overlying superior transverse suprascapular ligament (STSL) are considered the leading and most common cause.For this reason, researchers had paid more attention to SSN and proposed different classifications that describe its variations *(Zahid et al., 2014)*.

One of the most cited classifications is that of *Natsis et al. (2007)* that distinguished five types of the SSN. The first type lacks a discrete notch, the second presents a wide notch, the third presents a deep notch, the fourth type in which the STSL is ossified and the notch is converted to bony foramen and the fifth type in which the scapula has a notch above a bony foramen. There is a strong correlation between the suprascapular neuropathy and the ossified STSL *(Piasecki et al., 2009)*.

Iqbal et al. (2010) introduced a morphological classification for the SSN which includes three shapes U, J and V shaped notches. U-shaped notch has the highest frequency among Egyptians (76.27%) *(Mahdy and Shehab, 2013)*, J-shaped is the most prevailing shape among Indians (43.26%) and V-shaped notch which is commonly encountered among Pakistanians (20%) *(Iqbal et al., 2010). Wang et al. (2011)* had observed that in patients with suprascapular neuropathy, the nerve is usually compressed and is introduced to repetitive friction which causes injury to the nerve, the latter is usually caused by small sized V-shaped notch, narrow or absent notch as well as notches with ossified STSL *(Akhtar and Madhukar, 2014)*.

The anterior coracoscapular ligament (ACSL) is a recent anatomical finding which has been reported as the newest potential risk factor for SNES *(Podgórski et al., 2015)*. its presence divides the narrow SSN into narrower two or even three compartments, if it was bifid. Moreover, the suprascapular vessels may have a variable course and pass under the STSL in the SSN together with the nerve, aggravating the nerve compression *(Gürses et al., 2015)* which could be complicated by irreversible muscle paralysis *(Himabindu et al., 2013)*.

Snapping scapula syndrome could be caused by hooking of the superomedial scapular luschka tubercle, teres major process and the presence of concave medial scapular border *(Totlis et al., 2014)*. Snapping scapula syndrome is a largely under-recognized disorder of the scapulothoracic joint, characterized by palpable, audible and sometimes painful crepitus. It has been described by other names including washboard syndrome, scapulothoracic bursitis, scapulothoracic crepitus and scapulocostal syndrome *(Totlis et al., 2014)*. Orthopedic surgeons must bear this disorder in mind so as not to be overlooked and to be properly managed. Careful assessment of those patients is extremely important because if there is a bony factor, conservative management usually fails and permanent cure is achieved surgically through partial scapulectomy *(Freche et al., 2015)*.

Acromion index and acromiohumeral interval are two highly reliable radiological tools used in diagnosis and surgical decision making concerning cases of advanced rotator cuff tear *(Aydingöz et al., 2014)*. However the studies that describe their normal ranges in literature are scarce.

MATERIAL AND METHODS

1-Material

A) Dry Bone Study

One hundred dried scapulae (60 left and 40 right) were studied for their different morphological and morphometric variations. The specimens were obtained from the Anatomy Department, Faculty of Medicine, Cairo University.

B) Radiographic Study

Shoulder radiographs A/P view of one hundred persons; 60 males (30right and 30 left) and 40 females (25right and 15 left) were used in this study. The radiographs were obtained from accredited private radiology centers.

2- Methods

A) Dry Bone Study:

Morphological Parameters:

1. Morphological variations of the acromion process:

- Type according to the slope of its undersurface (profile view); flat (type-1), curved (type-2), hooked (type-3) and convex downwards (type-4) *(Bigliani et al. 1991)*.

- Shape (top view): tubular (Cobra-head) shape in which the acromion is elongated (AL > AW) and its tip is rounded or tapered on both sides, triangular where the acromion medial and lateral borders are converging with narrow tip and wide base, rectangular in which the acromion is elongated (AL>AW) with parallel medial and lateral borders and its tip is flattened, and square where the acromion medial and lateral borders are parallel *(Mansur et al., 2012)*.

- Appearance of its undersurface whether smooth or rough.

- Thickness whether thick or thin.

2. Morphological variations of the suprascapular notch (SSN):

- Five types of the SSN following the classification of *Natsis et al. (2007)*: type-1: Absent notch, type-2: wide notch type-3: deep notch type-4: bony foramen (completely ossified STSL). Type-5: a notch above a bony foramen.

- Three shapes of the SSN (U, V and J) as described by *Iqbal et al. (2010)*.

3. Anatomical variations causing snapping scapula:

- Existence of lushka tubercle *(Totlis et al., 2014)*.

- Presence of a teres major process *(Totlis et al., 2014)*.

- Shape of the medial border: convex, straight or concave *(Totlis et al., 2014)*.

Morphometric Parameters:

- *Acromion length (AL)*: The distance between the tip of the acromion and the midpoint of its posterior border *(Gupta et al., 2015)*.

- *Acromion width (AW)*: The distance between the midpoints of the medial and lateral borders of the acromion *(Gupta et al., 2015)*.

- *Acromio-glenoid distance (AGD)*: The distance between the tip of acromion and supraglenoid tubercle *(Mansur et al., 2012)*.

- *Acromio-coracoid distance (ACD)*: The distance between the tip of acromion and tip of the coracoid process *(Mansur et al., 2012)*

- *Acromion thickness*: measured 1cm posterior to the anterior border and 1cm medial to the lateral border *(Nasr El Din and Ali, 2015)*.

- *Angulation of the medial border*: The angle between the supraspinous and infraspinous portions of the medial border in the sagittal plane measured using a metal protractor *(Totlis et al., 2014)*

- All measurements were done twice and the mean was recorded to decrease the bias errors. Distances were estimated by using sliding Vernier caliper and measuring tape, recorded in millimeters (mm). Photographs were taken by digital camera SONY, Cyber-shot, 16.1 megapixels, Carl Zeiss lens.

B) Radiographic Study (Figs I and II):

- Radiographs were taken with the subject standing and the arm in neutral position.

- Two parameters were calculated on conventional shoulder X-rays A/P view.

- Radi-Ant DICOM viewer, a program for radiographs analysis and measurement was applied to calculate the indices.

1. Acromion Index (AI) : calculated from the equation: AI = GA/GH (Gu and Yu, 2013)

2. Acromio-humeral Interval (AHI):The least distance between the undersurface of the acromion and the upper surface of the head of humerus (Gu and Yu, 2013)

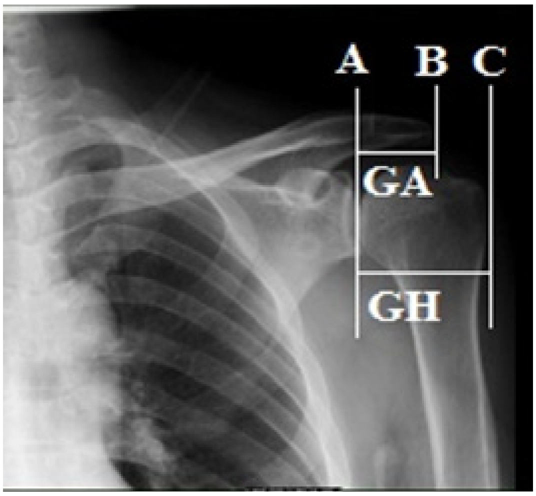

Fig. (I): Shoulder radiograph (A/P view) showing the acromion index, GA: The distance between the line of the plane of the glenoid cavity (line A) and the line tangent to the lateral border of the acromion (line B).

Fig. (II): Shoulder radiograph (A/P view) showing the acromio-humeral interval calculated between two parallel lines; line a: the tangent to the undersurface of the acromion, line b: the tangent to the most superior point

C) Statistical Analysis:

Data was analyzed using IBM SPSS advanced statistics version 21 (SPSS Inc., Chicago, IL). For quantitative data, comparison between two dependent groups was done using student paired t-test.Chi square test (X^2) was applied for the qualitative data to obtain the frequencies of the morphological variations on both sides.

Pearson correlation was done to correlate between the following parameters:

- Acromion length and acromion width.
- Acromion length and acromio-glenoid distance.
- Acromion length and acromio-coracoid distance.
- Acromion width and acromio-glenoid distance.
- Acromion width and acromio-coracoid distance.
- Acromio-glenoid distance and acromio-coracoid distance.

Correlation was considered significant at p-value < 0.05 and highly significant at p-value < 0.01.

RESULTS

A) Dry bone study

1) The acromion process

a. Acromion type: four types of acromion were observed: type-1(flat) (Fig. 1a) constituted 34% of the total number, type-2 (curved) (Fig.1b) constituted 52% of the total, Type-3 (hooked) (Fig.1c) that was observed in 13% of the studied bones Type-4 (convex downwards) (Fig. 1d) and was observed in only one left sided scapula (1%).

b. Acromion shape: four shapes were identified

Tubular (Fig. 2a) was observed in 44% of the total number, *triangular* (Fig. 2b) was seen in 27% (15% of the left side and 12% of the right. Rectangular (Fig.2c) and this shape constituted 21% (14% of the left side and 7% of the right). Square shape (Fig. 2d) was observed in 8% (6% of the left side and 2% of the right.

c. Acromion undersurface appearance: 84% of had smooth undersurface (Fig. 3a), and 16% had rough undersurface with osteophytes formation (Fig. 3b).

d. Acromion thickness: ranged from 5 to 11mm. 57% of the studied specimens were thick (≥7mm), and 43% were thin (<7 mm (Table 1).

e. Acromion length (AL): ranged from 24 to 65mm (Table 1 and Fig.4).

f. Acromion width (AW): ranged from 18 to 40mm (Table 1 and Fig.4).

g. Acromio-glenoid distance (AGD): ranged from 20 to 40mm (Table 1 and Fig.4).

h. Acromio-coracoid distance (ACD): ranged from 22 to 68mm (Table 1 and Fig.4)

The correlation between the acromion length and each of the acromion width, acromio-glenoid distance and acromio-coracoid distance, acromion width and each of the acromio-glenoid distance and acromio-coracoid distance, as well as between the acromio-glenoid distance and acromio-coracoid distance was done using pearson rank correlation and is represented in (Table 2 and Figs. 5 and 6).

2) The suprascapular notch (SSN)

a) Suprascapular notch type (Table 3):

Type-1 (Fig. 7a) constituted 10% of the total number 24% of the left side and 15% of the right, type-2 (Fig. 7b) was found in 39%, type-3 (Fig. 7c) was present in 43%,Type-4 (Fig. 7d) was seen in 5% and Type-5 (Fig. 7e) was encountered in 3% of the studied bones.

b) Suprascapular notch shape (Table 3):

U-shaped notch (Fig.8a) which was found in 41.1 , *V-shaped notch* (Fig. 8b), that was found in 30.5% (n=26) of the total number: 18.8% *J-shaped notch* (Fig. 8c) that was found in 27.1%, *W-shaped notch* (Fig. 8d) and this shape was encountered for the first time, it has not been described before in literature, it is a composite of two compartments beside each other, it was found in only one right sided scapula (1.1%).

c) Pattern of ossification of the STSL (Table 4):

Absent ossification (Figs. 7b, 7C, 8b and 8c) in 54%, *Partial ossification*: was observed in 41%, this group was further subdivided according to the site of ossification into Partial ossification of one edge: in 17% (Fig. 8e), *partial ossification* of both edges: in 12% (Fig. 8f), complete ossification: 5% showed a bony foramen (3% on the left side and 2% on the right) (figs. 7D and 8h). Additionally, one right sided scapula was encountered showing partial ossification of the anterior coraco-scapular ligament in a V shaped notch, without ossification of the STSL (Fig. 8g).

3) Anatomical variations causing snapping scapula:

a) **Lushka tubercle** in the supero-medial angle (Table 5 and fig. 9a).

b) **Teres major process (Fig. 10a)** in the inferior portion of the lateral border was present in 40%; it showed forward curvature towards the chest wall in 50% of the scapulae possessing the teres major process (Table 5). Angulation of the medial border: ranged from 115˚ to 170˚(Fig. 11) and Shapes of the medial border are (Fig. 12): convex in 59% , Straight: in 30%, and Concave: in 11%.

The correlation between Lushka tubercle and angulation of the medial border was done using pearson correlation and represented in (Table 6).

B) Radiographic Study (table 7):

1. Acromion index (AI) ranged from 0.65 to 0.68 (p- value < 0.07) of both sexes (p- value <0.09).

2. Acromio-humeral interval (AHI) ranged from 7 to 14mm. AHI was 10.13 ± 2.11mm in males, while it was 11.21 ± 2.19mm in females.

Table 1: Values of acromion morphometric parameters of both sides

	Side	(n)	Mean ± SD	Significance
Acromion length	Left	60	45.88 ± 7.55	0.6 (NS)
	Right	40	47.78 ± 7.97	
Acromion width	Left	60	25.77 ± 3.85	0.6 (NS)
	Right	40	25.73 ± 3.69	
Acromion thickness	Left	60	9.22 ± 2.31	0.07 (NS)
	Right	40	8.94 ± 2.73	
AGD	Left	60	30.62 ± 3.87	0.3 (NS)
	Right	40	29.73 ± 3.97	
ACD	Left	60	40.58 ± 7.28	0.1 (NS)
	Right	40	37.6 ± 8.25	

(NS): Statistically non-significant using independent t –test

Table 2: Correlations between the acromion morphometric parameter

		Acromion length	Acromion width	AGD	ACD
Acromion length	Pearson Correlation	1	.276**	-.163-	-.227-*
	Sig. (2-tailed)		.276**	.105	.023
Acromion width	Pearson Correlation	.276**	1	.214*	.169
	Sig. (2-tailed)	.006		.032	.093
AGD	Pearson Correlation	-.163-	.214*	1	.663**
	Sig. (2-tailed)	.105	.032		.000
ACD	Pearson Correlation	-.227-*	.169	.663**	1
	Sig. (2-tailed)	.023	.093	.000	

* Significant correlation at p<0.05
** Highly significant correlation at p<0.01

Table 3: The frequency of the SSN shapes and types of both sides

			Side			
			Left (n = 60)	Right (n = 40)	Total (n = 100)	P value
SSN shape	U	n =	20	15	35	0.5 (NS)
		% of Total	23.5%	17.6%	41.1%	
	J	n =	16	10	26	
		% of Total	18.8%	11.8%	30.6%	
	J	n =	12	11	23	
		% of Total	14.1%	12.9%	27.1%	
	W	n =	0	1	1	
		% of Total	0.0%	1.1%	1.1%	
SSN Type	Type 1	n =	9	1	10	0.5 (NS)
		% of Total	9.0%	1.0%	10.0%	
	Type 2	n =	24	15	39	
		% of Total	24.0%	15.0%	39.0%	
	Type 3	n =	23	20	43	
		% of Total	23.0%	20.0%	43.0%	
	Type 4	n =	3	2	5	
		% of Total	3.0%	2.0%	5.0%	
	Type 5	n =	1	2	3	
		% of Total	1.0%	2.0%	3.0%	

(NS): statistically non-significant using Chi Square (X^2) test

Table 4: The frequency of variations of STSL of both sides

			Side			
			Left (n =60)	Right (n = 40)	Total (n =100)	P value
STSL	Absent ossification	(n)	31	23	54	0.6 (NS)
		%	31.0%	23.0%	54.0%	
	Partially ossified medially	(n)	13	4	17	
		%	13.0%	4.0%	17.0%	
	Partially ossified laterally	(n)	7	5	12	
		%	7.0%	5.0%	12.0%	
	Partially ossified both edges	(n)	6	6	12	
		%	6.0%	6.0%	12.0%	
	Ossified completely (foramen)	(n)	3	2	5	
		%	3.0%	2.0%	5.0%	

(NS): statistically non-significant using Chi Square (X^2) test

Table 5: The frequency of Lushka tubercle and teres major process

			Side: Left (n = 60)	Side: Right (n = 40)	Total (n = 100)	p-value
Lushka Tubercle	Absent	(n)	32	26	58	0.2 (NS)
		%	32.0%	26.0%	58.0%	
	Present	(n)	28	14	42	
		%	28.0%	14.0%	42.0%	
Teres major Process	Absent	(n)	38	22	60	0.3 (NS)
		%	38.0%	22.0%	60.0%	
	Present	(n)	22	18	40	
		%	22.0%	18.0%	40.0%	

(NS): statistically non-significant using Chi Square (X^2) test

Table 6: The correlation between Lushka tubercle and angulation of the medial border

		Lushka Tubercle	Angulation of medial border
Lushka tubercle	Pearson correlation	1	-.006-
	Sig. (2-tailed)		.951
Angulation of medial border	Pearson correlation	-.006-	1
	Sig. (2-tailed)	.951	

Table 7: Values of AI and AHI of both sexes on both sides

	Males (n=60)		Females (n=40)		Sex difference P-value
Side	Right (n=30)	Left (n=30)	Right (n=25)	Left (n=15)	
AI	0.68 ± 0.04	0.67 ± 0.06	0.65 ± 0.07	0.66 ± 0.05	0.09
AHI (mm)	10.13 ± 2.11	10.18 ± 2.9	11.2 ± 2.19	11.1 ±2.09	0.01*
Side difference P-value	0.07		0.008*		

* Statistically significant using independent t-test

Table 8: the frequency of the SSN shapes among different populations

Authors, year Population	SSN shapes: U-shaped	V-shaped	J-shaped
Iqbal *et al*., 2010 Pakistanians	13%	20%	22%
Sinkeet *et al*., 2010 Kenyans	50%	5.18%	-
Soni *et al*., 2012 Italians	58%	7%	27%
Himabindu *et al*., 2013 Indians	67%	7%	11.6%
Mahdy and shehab, 2013 Egyptians	76.27%	13.56%	10.17%
Vasudha *et al*., 2013 South Indians	46.8%	-	19.13%
Nagaraj *et al*., 2014 North Indians	26.9%	1.96%	43.26%
Present study, 2016	40%	25%	22%

Table 9: The incidence of bony foramen among different populations

Authors, year	Population	Incidence of bony foramen
Natsis *et al*., 2007	German	7.3%
Silva *et al*., 2007	Brazilian	30.6%
Sinkeet *et al*., 2010	Kenyan	3%
Wang *et al*., 2011	Chinese	4.08%
Jadhav *et al*., 2012	Indian	10.6%
Polguj *et al*., 2013	Polish	7%
Mahdy and Shehab, 2013	Egyptian	3.03%
Tubbs *et al*., 2013	American	3.7%
Zahid *et al*., 2014	Pakistanian	1.96%
Gopal *et al*., 2015	Indian	3.33%
Present study, 2016	Egyptian	5%

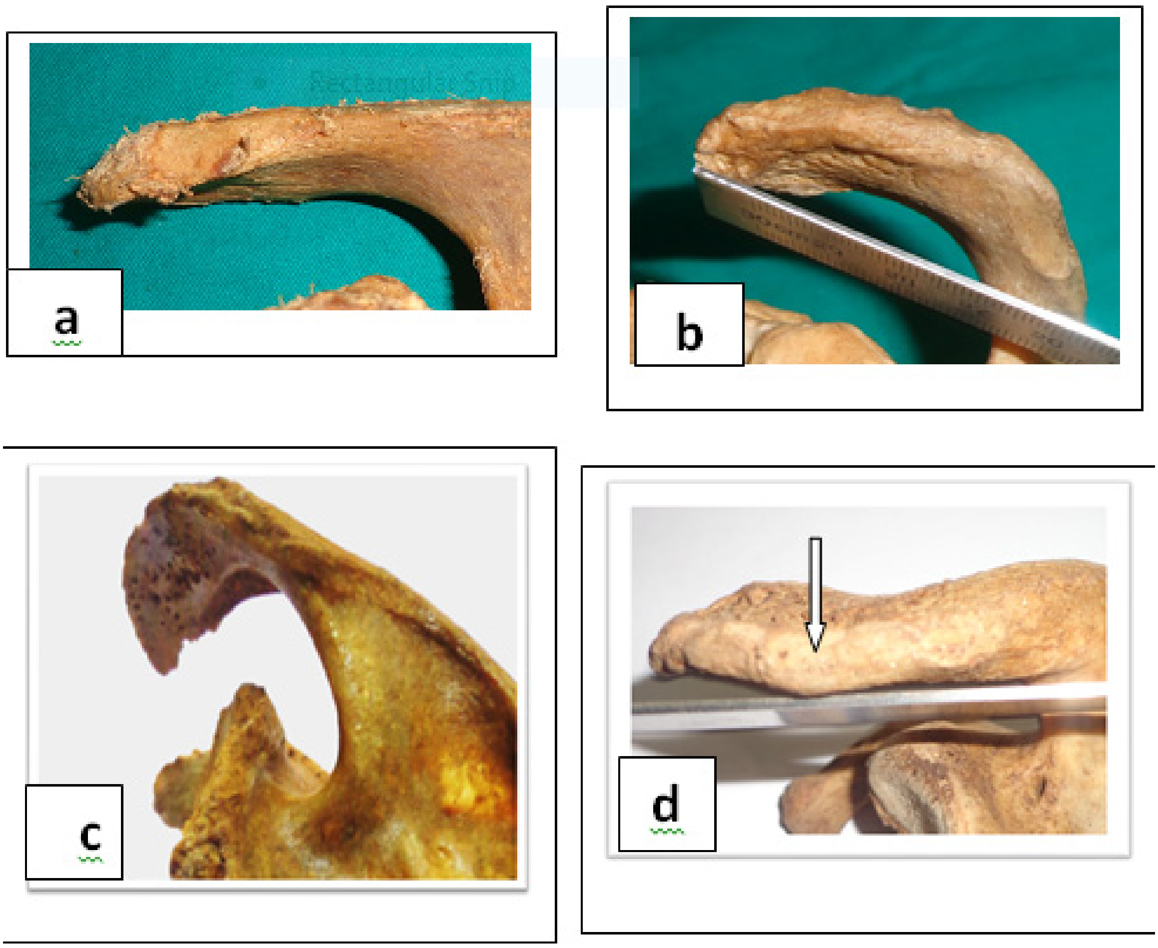

Fig. 1: Photographs showing different types of acromion process; (a)Flat acromion (type-1), (b) Curved acromion (type-2),(c) Hooked acromion (type-3), (d) Convex acromion(type-4) (arrow).

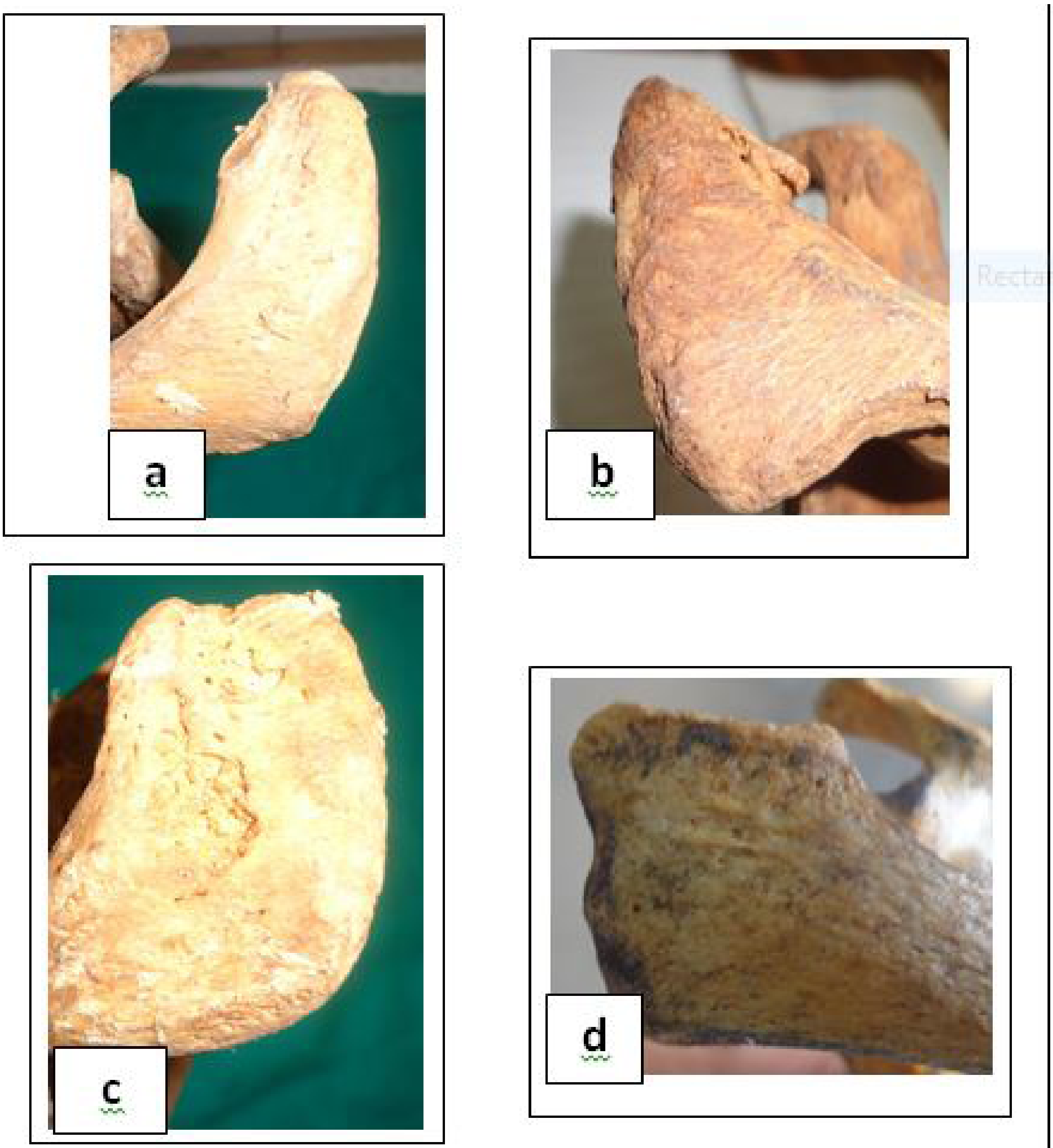

Fig. 2: Photographs showing different shapes of acromion (a) Cobra head (tubular), (b) Triangular ,(c) Rectangular acromion and (d) Square acromion.

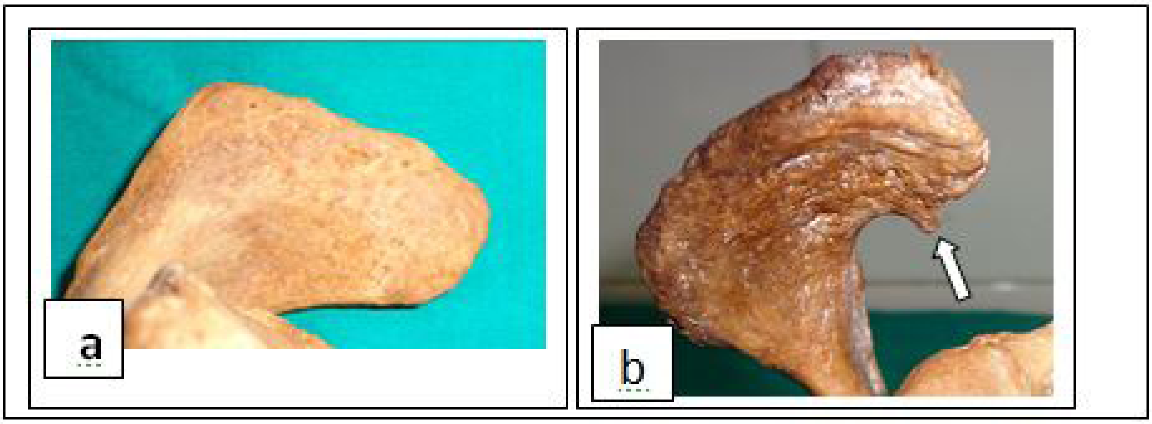

Fig. 3: Photographs showing Acromion undersurface appearance: acromion with smooth undersurface(a) and with rough undersurface and bone spur (arrow)(b)

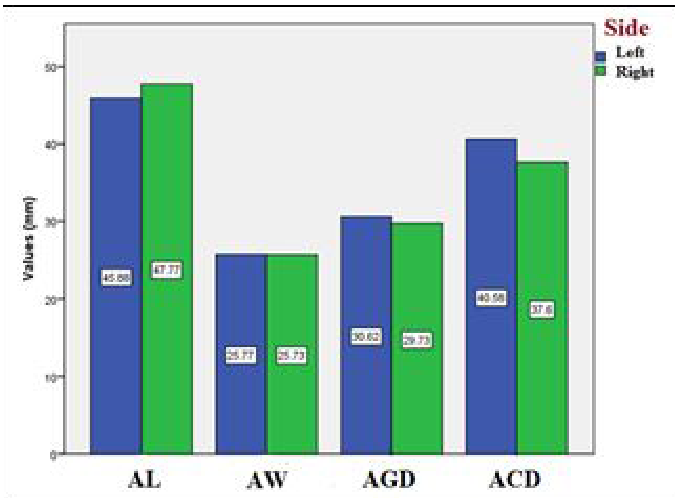

Fig. 4: Bar chart of the means of acromion morphometric variables of both sides; AL: acromion length, AW: acromion width, AGD: acromio-glenoid distance, ACD: acromio-coracoid distance.

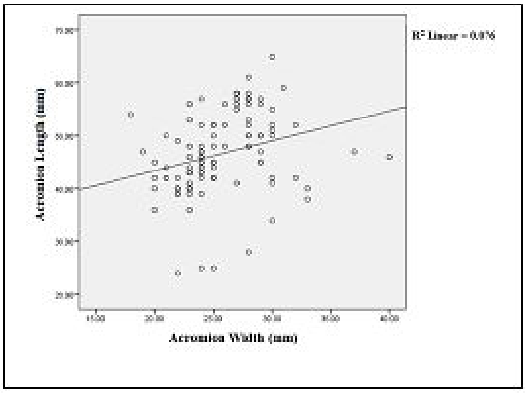

Fig. 5: Scatter plot showing the correlation between acromion length and acromion width.

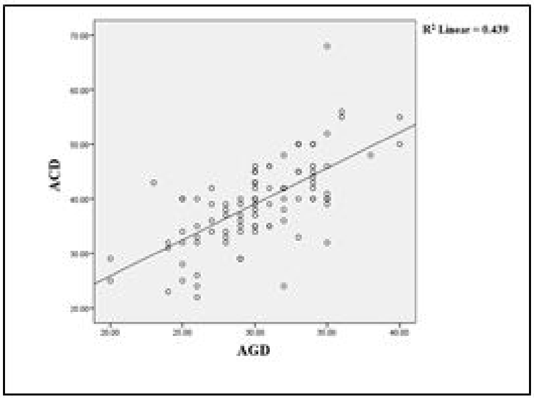

Fig. 6: Scatter plot showing the correlation between acromio-glenoid distance (AGD) and acromio-coracoid distance (ACD).

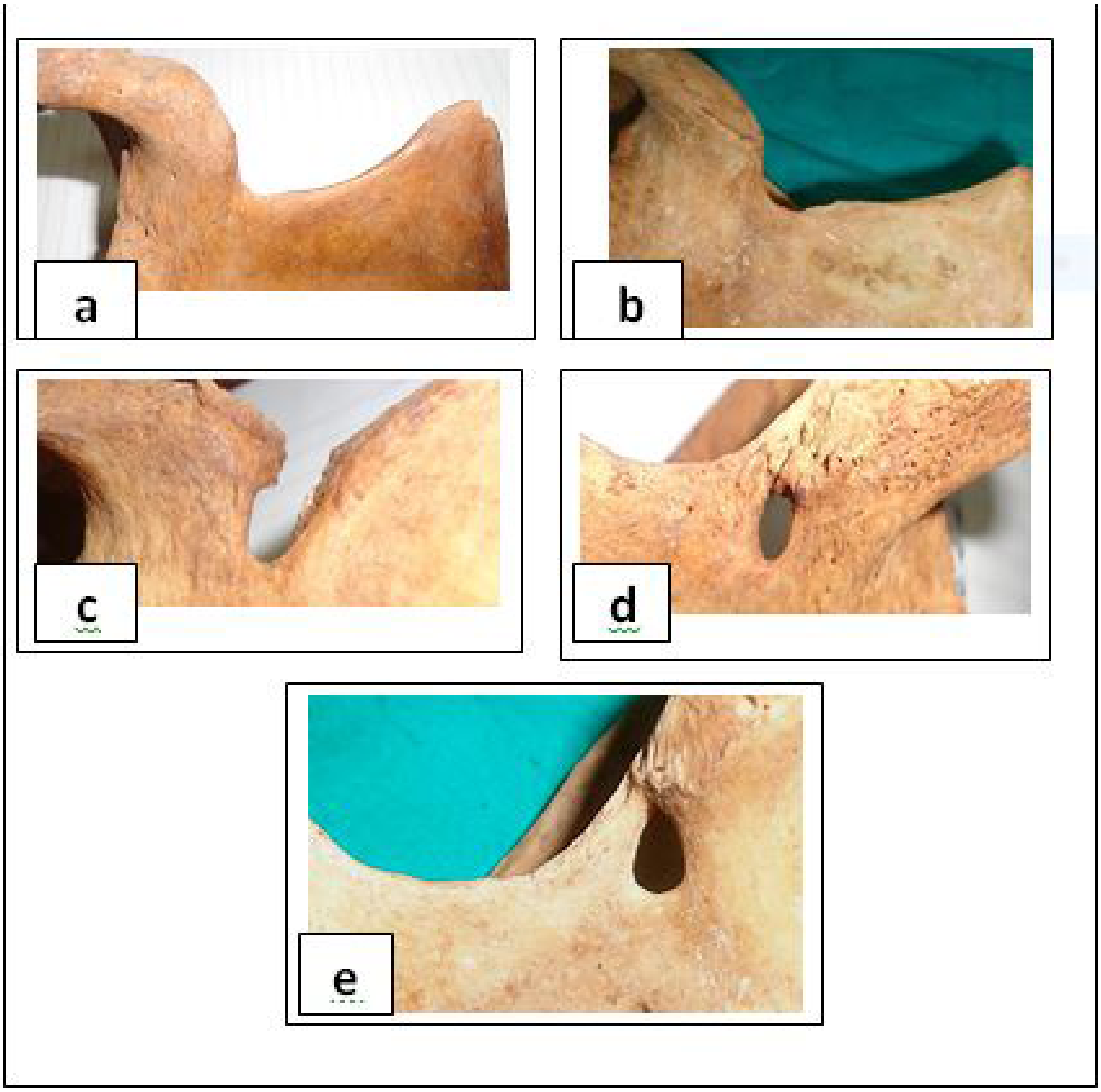

Fig. 7: Photographs showing different types of suprascapular notches: (a)type 1 with no suprascapular notch, (b)type 2 with wide shallow notch, (c) type 3 with deep notch, (d) type 4 with a bony foramen, (e)type 4 with a notch above bony foramen .

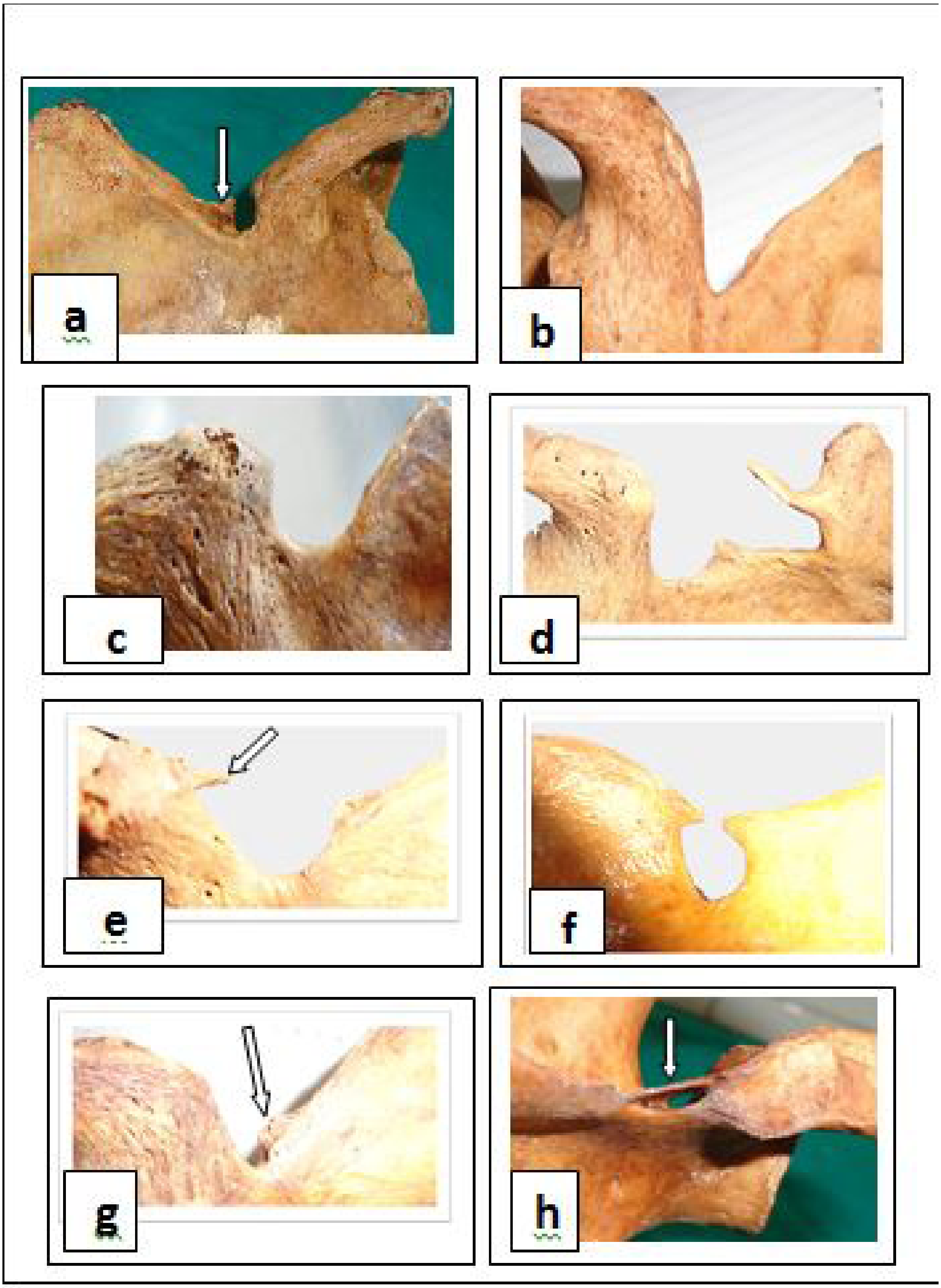

Fig. 8: Photographs showing different shapes of suprascapular notches and pattern of of ossification of related ligaments: (a) U shaped with bony plate (arrow), (b) v shaped ,(c) j shaped (d) W shaped ,(e) partial ossification of superior transverse scapular ligament lateral edge (arrow), (f) partial ossification of superior transverse scapular ligament from both edges, (g) partial ossification of anterior coracoscapular ligament (arrow), (h) completely ossified superior transverse scapular.

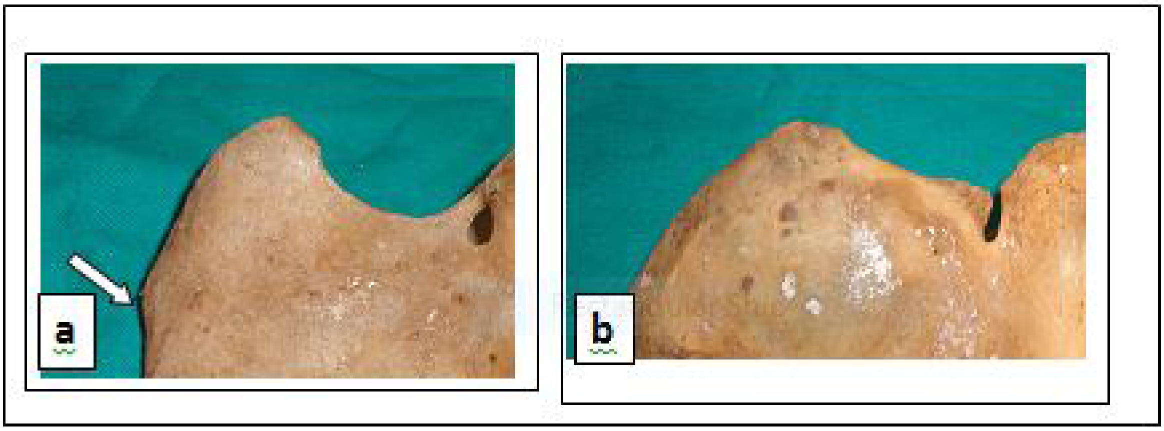

Fig. 9: Photograps of anterior view of two left scapulae showing the superomedial angle, (a) with Lushka tubercle, (b) without Lushka tubercle

Fig. 10: A Photomicrograph of the inferior portion of the lateral border in two left scapulae, (a) with teres major process, (b) without teres major process.

Fig. 11: Photographs of the medial border of the scapula showing its angulation, excessive forward hooking of the supraspinous portion of the medial border (a), excessive forward hooking of the medial border and thickened Lushka tubercle in the superomedial angle (arrows), no hooking of the medial border (c).

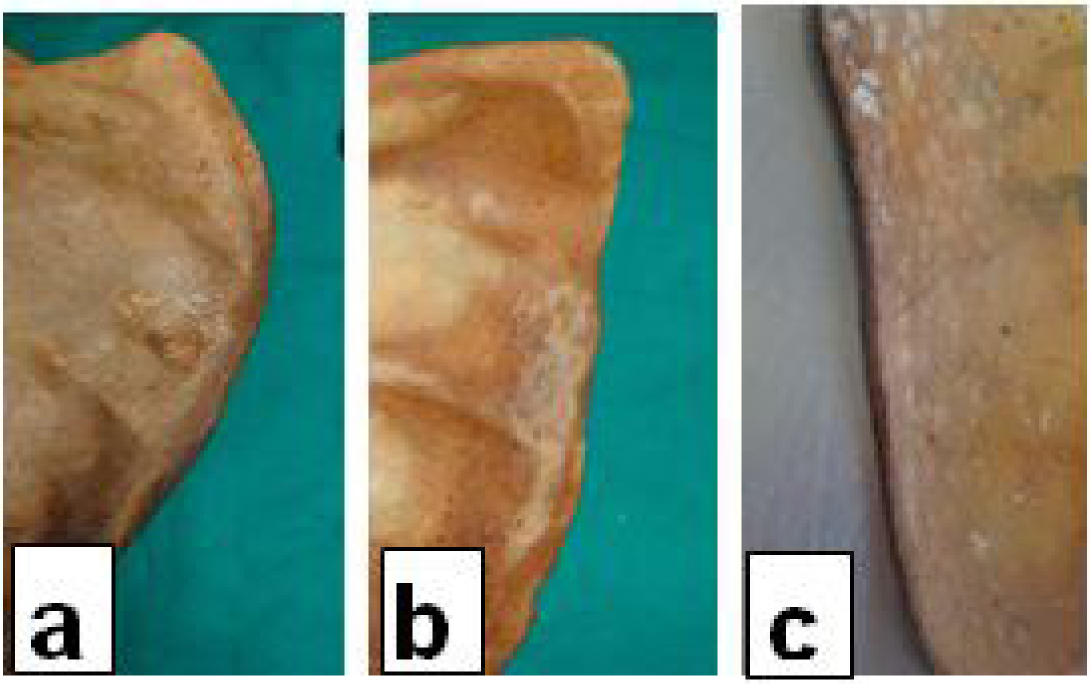

Fig. 12: Photographs of anterior view of the medial border of the scapula showing its different shapes, a: convex, b: straight and c: concave.

DISCUSSION

The scapula in the present work exhibited numerous forms of variation regarding the acromion process, suprascapular region, superomedial angle as well as the medial and lateral borders.

In this work four different shapes of the acromion were identified; tubular (cobra-head), triangular, rectangular and square with frequencies of 44%, 27%, 21% and 8% respectively. This differs from earlier studies by Mansur *et al*., (2012), Gupta *et al*., (2015) and Nasr El Din and Ali (2015) among Nepalese, Indian and Egyptian populations respectively, where the most frequent shape was the rectangular while the least was the tubular.

Regarding the types of acromion, type-2 acromion was the most frequent (56%), followed by type-1 (34%) then type-3 (13%). These percentages agree with those reported by Coskun et al., (2006), Paraskevas *et al*., (2008), Collipal et al., (2010) and Nasr El Din and Ali, (2015) among Turkish, Greeks, Chillians and Egyptians, respectively. On the other hand, Gupta *et al*. (2015) reported type-3 as the most frequent among Indians.

One left sided scapula was encountered in the present study possessing a convex acromion; an unusual form which is rarely described in previous studies; Vanarthos and Monu (1995) added this form to the standard classification as type-4 acromion.

Most of the studied acromion in the present study had smooth undersurface 84%, while 16% ; 14 were hooked and 2 were curved. This emphasizes the strong correlation between the increased curvature of the acromion and the increased liability for development of degenerative changes (Paraskevas *et al*., 2008). Ogawa *et al*. (2005) assumed that osteophytes develop in cases of chronic impingement as a degenerative process and once formed; they continue to deteriorate the condition, while Vähäkari *et al*. (2010) claimed that the primary morphology of the acromion is genetically controlled and does not change with age.

The acromion thickness in the present work goes hand in hand with those obtained by Nasr El Din and Ali (2015), but is much higher than those of Paraskevas *et al*. (2008), Singh *et al*. (2013) and Gupta *et al*. (2015). Accordingly, the acromion of Egyptian scapulae seems to be thicker than those of other populations, this may be attributed to the ethnic origin.

The current mean values of the AGD and ACD agree with those of Nepalese population (Mansur *et al*., 2012), but it is much higher than those of Indians (Gupta *et al*., 2015). Nevertheless, similar to previous studies, no significant side difference was detected.

In the present study, a highly significant correlation was detected between acromion length and width on one hand and acromio-glenoid and acromio-coracoid distance on the other. Consequently, the size of the subacromial space and the coracoacromial arch are greatly influenced by the dimensions of the acromion. Up to our knowledge these correlations were not reported before in the available literature.

In the present study morphological classification of the SSN was done following Iqbal *et al*. (2010), it comprises three different shapes; U, V and J, their frequencies vary among different populations (Table 8).

There is a consensus that the chance of SN entrapment in V-shaped notches is higher than that in other shapes, since it has smaller surface area, higher percentage of associated partial ossification of STSL and converging sharp borders (Nagaraj *et al*, 2014). A unique shape not previously reported was encountered in this study which is a W-shaped SSN.

In the present work, five types of notches were determined, type-1 SSN was found in 10%, which is close to results of Natsis *et al*., (2007) (8.3%) and Iqbal *et al*. (2011) (10%) among Germans and Pakistanians, respectively. However, Sinkeet *et al*. (2010); Wang *et al*. (2011) and Nagaraj *et al*. (2014) reported much higher values; (24%), (28%) and (23%) among Kenyans, Chinese and Indians, respectively. This type is one of the potential causes of SN entrapment (Akhtar and Madhukar, 2014).

In the present study, type-2 SSN (39%), and Type-3 SSN (43%), were the most prevalent types, this come in accordance with Natsis *et al*. (2007) and Alagwany *et al*. (2014), Type-4 SSN (5%) is a foramen that results of complete ossification of the overlying STSL. The incidence of bony foramina varies widely among different populations (Table 9).

In the present study, type-5 SSN found in 3% of bones; a higher result than of all previous studies. Few authors have reported it; Natsis *et al*. (2007) found it in 0.7%, Sinkeet *et al*. (2010), Vasudha *et al*., (2013), Saritha, (2014) and Jangde *et al*., (2015) all reported it in 1% of bones.

In the present study, different patterns of ossification of STSL have been observed. Moreover, there was an obvious variability among the length and thickness of the ossified ligament. Saritha, (2014) estimated the reduction in the area of the notch below an ossified STSL to be 36- 39% of its size, thus the presence of ossified STSL is reasonable to be considered a sign of suprascapular entrapment.

The tendency of the STSL to ossify may be attributed to the fibrocartilagenous character of the ligament, response to mechanical load or genetic basis. Furthermore, the presence of ossified ligaments poses a challenge during arthroscopic procedures in this narrow surgical field, and have to be resected to ensure adequate nerve decompression (Gopal *et al*., 2015).

In the present study, the measurement of the angle of the medial border subtended at the root of the spine of scapula is quite close to that obtained by Oizumi *et al*. (2004); Lehtinen *et al*. (2005) and Aggarwal *et al*. (2011) in Hong Kong, Germany and India, respectively, whereas it is less than the results of Totlis *et al*. (2014) in France, by about 15˚ for both sides, this difference may be attributed to the different races, techniques and tools used for measurement.

According to (Lehtinen *et al*., 2005), medial border angulation <130˚ is considered a diagnostic sign of snapping that needs a radical resection of the superomedial angle to decompress the scapulothoracic space. The triggering points (hot spots) in the scapula inducing this disorder are localized mainly in the superomedial angle, inferior angle and the medial border, which are the sites of pain presented by the patients (Warth *et al*., 2015).

Lushka tubercle and teres major process were reported in few studies in literature, in the current work they were observed in 42% and 40% of the studied bones respectively, which are much higher than the results of Totlis et al. (2014) who reported them in 3% and 43% of their sample. This denotes that they are common anatomical variation and not rare as it was previously thought. The negative correlation deduced in the current study between the degree of angulation of the medial border and Lushka tubercle, reveals that with more hooking, there is higher incidence of formation of Lushka tubercle, thus, chronic friction with the thoracic cage may have a role in Lushka tubercle formation. Up to our knowledge this correlation has not been discussed before.

Teres major process projecting towards the thoracic cage, in addition to its lateral projection, was found to be much higher than all previous studies, while the incidence of the concave type was 11%, which matches with earlier results reported by Kuhne *et al*. (2009) and Totlis *et al*. (2014) who found the concave type in 9% and 11.4% among Americans and French, respectively.

In the present work, the AI of the normal shoulders was calculated for both sexes on both sides, it was higher than that was previously deduced by Torrens *et al*. (2007) among Spanish population, the higher value of the AI may justify the high probability of developing subacromial impingement and consequently rotator cuff pathology among Egyptian population.

CONCLUSION

Computed In the current study, the mean value of AHD was near to that obtained by Goutallier *et al*. (2011) among French population. Unlike the previous studies, gender and side differences were taken into consideration in this study. AHD was much lower in males than in females, that was statistically significant, adding to that, AHD was significantly lower on the right than on the left side; this may be attributed to the influence of hand dominance and workloads, muscular activities and effort exerted by the respective shoulder.

On comparing the measurements of AHD obtained from the conventional radiographs and MRI, there was no significant difference in results of both methods, with a proved good inter and intra-observer reliability on using radiographs (Goutallier et al., 2011).

REFERENCES

Adolfsson, L. (2015): Is surgery for the subacromial pain syndrome ever indicated?. Acta Orthop.; 86(6): 639-640.

Aggarwal, A., Wahee, P., Aggarwal, A.K. and Sahni, D. (2011): Variable osseous anatomy of costal surface of scapula and its implications in relation to snapping scapula syndrome. Surg. Radiol. Anat.; 33(2): 135-140.

Akhtar, M.J. and Madhukar, P.K. (2014): A Study on Complete Absence of the Suprascapular Notch. Int. J. Sci. Res.; 3(11): 411-415.

Alagwany, A., Awad, A. and Abd El Raouf, A. (2014): Variations in Anatomy of the Suprascapular Notch Possibly Causing Suprascapular Nerve Entrapment: An Anatomical Study. Egypt J. Anat.; 37(1): 67-78.

Aragão, J.A., Silva, L.P., Reis, F.P., Menezes, C.S. (2014): Analysis on the acromial curvature and its relationships with the subacromial space and types of acromion. Rev. Bras. Ortop.; 49(6): 636-641.

Aydingöz, Ü., Canbulat, N. and Demirhan, M. (2014): Radiological Assessment of the Shoulder Region. Turk. J. Phys. Med. Rehab.; 60 (Supp. 1): S68-S77.

Bigliani, L.U., Ticker, J.B., Flatlow, E.L., Soslowsky, L.J. and Mow, V.C. (1991): The relationship of acromial architecture to rotator cuff disease. Clin. Sports Med. J.; 10(4): 823-838.

Collipal, E., Silva, H., Ortega, l., Espinoza, E. and Martınez, C. (2010): The acromion and its different forms. Int. J. morphol.; 28(4):1189-1192.

Coskun, N., Karaali, K., Cevikol, C., Bahadir, M., Demirel, B.M. and Sindel, M. (2006): Anatomical basics and variations of the scapula in Turkish adults. Saudi Med. J.; 27 (9): 1320-1325.

Fatima, T., Vanitha, H.S. and Kadlimatti, H. (2015): Double Suprascapular Foramina: An Anatomical Variation. Int. J. Med. Res Health Sci.; 4(2): 439-441.

Freche, S., Juch, F., Nusselt, T., Delank, K.S. and Hagel, A. (2015): Arthroscopic treatment of bilateral snapping scapula syndrome: a case report and review of the literature. Acta. Orthop. Traumatol. Turc.; 49(1): 91-96.

Gopal, K., Choudhary, A.K., Agarwal, J. and Kumar, V. (2015): Variations in suprascapular notch morphology and its clinical importance. Int. J. Res. Med. Sci.; 3(1): 301- 306.

Goutallier, D., Le Guilloux, P., Postel, J.M., Radier, C., Bernageau, J. and Zilber, S. (2011): Acromio humeral distance less than six millimeter: Its meaning in full-thickness rotator cuff tear. Orthop. Traumatol. Surg. Res.; 97(3):246-251.

Gu, G., and Yu, M.Y. (2013): Imaging Features and Clinical Significance of the Acromion Morphological Variations. J. Nov. Physiotherapy; 2(3): 1-4.

Gupta, S., Magotra, R. and Kour, M. (2015): Morphometric analysis of glenoid fossa of scapula. J. Evol. Med. Dent. Sci.; 4(45): 7761-7766.

Gürses, İ.A., Gayretli, Ö., Coşkun, O., Kale, A. and Öztürk, A. (2015): Anatomical relations between anterior coracoscapular ligament and suprascapular neurovascular structures and a proposal for classification. Acta. Orthop. Traumatol. Turc.; 49(4): 433-437.

Himabindu, A., NarasingaRao, B. and Sannala, N. (2013): Suprascapular Notch Variations and Its Clinical Significance. Int. J. Cur. Res. Rev.; 5(22): 46-50.

Iqbal, K., Iqbal, R. and Khan, S.G. (2010): Anatomical variations in shape of suprascapular notch of scapula. J. Morphol. Sci.; 27(1): 1-2.

Jadhav, S.D., Patil, R.J., Roy, P.P., Ambali, M.P., Doshi, M.A. and Desai, R.R. (2012): Suprascapular foramen in Indian dry scapulae. National J. Clin. Anat.; 1(3): 133-135.

Jangde, S., Arya, R.S., Paikra, S. and Basan, K. (2015): Bony Suprascapular Foramen, A Potential Site For Suprascapular Nerve Entrapment: A Morphological Study On Dried Human Scapulae. Int. J. Anat. Res.; 3(3): 1316-1320.

Kharay, S.S., Sharma, A. and Singh, P. (2016): Unusual morphology of scapulae: incidence and dimensions of ossified ligaments and supraspinous bony tunnels for clinical consideration. Singapore Med. J.; 57(1): 29-32.

Kuhne, M., Boniquit, N., Ghodadra, N., Romeo, A.A. and Provencher, M.T. (2009): Current concepts the snapping scapula: diagnosis and treatment. Arthroscopy J.; 25(11):1298-1311.

Lehtinen, J.T., Tingart, M.J., Apreleva, M. and Warner, J.J. (2005): Quantitative Morphology of the Scapula: Normal Variation of the Superomedial Scapular Angle, and Superior and Inferior Pole Thickness. J. Orthop.; 28(5): 481-486.

Mahdy, A. A. and Shehab, A. A. (2013): Morphometric Variations of the Suprascapular Notch as a Potential Cause of Neuropathy: Anatomical Study. J. Am. Sci.; 9(3): 189-197.

Mansur, D.I., Khanal, K., Haque, M.K. and Sharma, K. (2012): Morphometry of acromion process of human scapulae and its clinical importance amongst Nepalese population. Kathmandu Univ. Med. J.; 10(38): 33-36.

Nagaraj, S., Krishnaiah, M., Kumar, P. and Sherke, A. (2014): Study of Morphological Variations of Suprascapular Notch. J. Dent. Med. Sci.; 13(6): 121-123.

Nasr El-Din, W.A. and Ali, M.H. (2015): A Morphometric Study of the Patterns and Variations of the Acromion and Glenoid Cavity of the Scapulae in Egyptian Population. J. Clin. Diagn. Res.; 9(8): 8-11.

Natsis, K., Totlis, T., Tsikaras, P., Appell, H.J., Skandalakis, P. and Koebke, J. (2007): Proposal for classification of the suprascapular notch: a study on 423 dried scapulas. Clin. Anat.; 20(2): 135-139.

Ogawa, K., Yoshida, A., Inokuchi, W. and Naniwa, T. (2005): Acromial spur: relationship to aging and morphologic changes in the rotator cuff. J. Shoulder Elbow Surg.; 14(6): 591-598.

Oizumi, N., Suenaga, N. and Minami, A. (2004): Snapping scapula caused by abnormal angulation of the superior angle of the scapula. J. Shoulder Elbow Surg.; 13(1): 115-118.

Paraskevas, G., Tzaveas, A., Papaziogas, B., Kitsoulis, P., Natsis, K. and Spanidou, S. (2008): Morphological parameters of the acromion. Folia Morphol (Warsz); 67(4): 255-260.

Piasecki, D.P., Romeo, A.A., Bach, B.R. and Nicholson, G.P. (2009): Suprascapular Neuropathy. J. Am. Acad. Orthop. Surg.; 17(11): 665-676.

Podgórski, M., Topol, M., Sibiński, M., Domżalski, M., Grzelak, P. and Polguj, M. (2015): What is the function of the anterior coracoscapular ligament? A morphological study on the newest potential risk factor for suprascapular nerve entrapment. Ann. Anat.; 201: 38-42.

Polguj, M., Sibiński, M., Grzegorzewski, A., Girzelak, P., Majos, A. and Topol, M. (2013): Variation in morphology of suprascapular notch as a factor of suprascapular nerve entrapment. Int. J. Orthop.; 37(11): 2185-2192.

Saritha, S. (2014): Coexistance of suprascapular notch and suprascapular foramen. A rare anatomical variation and its clinical correlation. A case report. Int. J. Med. Sci. clin. invent.; 1(2): 65-68.

Silva, J.G., Abidu-Figueiredo, M., Fernandes, R.M., Aureliano R.F., Sgrott, E.A., Silva, S.F. and Babinski, M.A. (2007): High Incidence of Complete Ossification of the Superior Transverse Scapular Ligament in Brazilians and its Clinical implications. Int. J. Morphol.; 25(4): 855-859.

Singh, J., Pahuja, K. and Agarwal, R. (2013): Morphometric parameters of the acromion process in adult human scapulae. Ind. J. Basic and Applied Med. Res.; 2(8): 1165-1170.

Sinkeet, S.R., Awori, K.O., Odula, P.O., Ogeng'o, J.A. and Mwachaka, P.M. (2010): The suprascapular notch: its morphology and distance from the glenoid cavity in a Kenyan population. Folia Morphol (Warsz).; 69(4): 241-245.

Soni, G., Malik, V.S., Shulka, L., Chabbra, S. and Gaur, N. (2012): Morphometric analysis of the suprascapular notch. Int. J. Bio. Anthrop.; 5(1): 20-27.

Torrens, C., López, J.M., Puente, I. and Cáceres, E. (2007): The influence of the acromial coverage index in rotator cuff tears. J. Shoulder Elbow Surg.; 16(3): 347-351.

Totlis, T., Konstantinidis, G.A., Karanassos, M.T., Sofidis, G., Anastasopoulos, N. and Natsis, K. (2014): Bony structures related to snapping scapula: correlation to gender, side and age. Surg. Radiol. Anat.; 36(1): 3-9.

Tubbs, R.S., Nechtman, C., D'Antoni, A.V., Shoja, M.M., Mortazavi, M.M., Loukas, M., Rozzelle, C.J. and Spinner, R.J. (2013): Ossification of the suprascapular ligament: a risk factor for suprascapular nerve compression?. Int. J. Shoulder Surg.; 7(1): 19-22.

Vähäkari, M., Leppilahti, J., Hyvönen, P., Ristiniemi, J., Päivänsalo, M. and Jalovaara, P. (2010): Acromial shape in asymptomatic subjects: a study of 305 shoulders in different age groups. Acta. Radiol.; 51(2): 202-206.

Vanarthos, W.J. and Monu, J.U. (1995): Type-4 acromion: A new classification. Contemp. Orthop.; 30(3): 227-229.

Vasudha, T.K., Shetty, A., Gowd, S. and Rajasekhar (2013): Morphological study of suprascapular notch and superior transverse scapular ligaments in human scapulae. Int. J. Med. Res. Health Sci.; 2(4): 793-798.

Wang, H.J., Chen, C., Wu, L.P., Pan, C.Q., Zhang, W.J. and Li, Y.K. (2011): Variable morphology of the suprascapular notch: an investigation and quantitative measurements in Chinese population. Clin. Anat.; 24(1): 47-55.

Warth, R.J., Spiegl, U.J., and Millett, P.J. (2015): Scapulothoracic Bursitis and Snapping Scapula Syndrome: A Critical Review of Current Evidence. Am. J. sports Med.; 43(1): 236-245.

Zahid, A., Khan, M.W. and Khan, B. (2014): Ossified superior transverse scapular ligament: a morphological study on dried Pakistani scapulae. Biomedica.; 30(3): 1-4.

التنوعات التشريحية في عظم لوح الكتف في المصريين البالغين: دراسة مورفولوجية و قياسية على العظم الجاف و صور الاشعة

محمد عماد؛ شريف فهمى؛ شيرين عبد الفتاح؛ ابتهال حسن

قسم التشريح و علم الاجنة، كلية الطب، جامعة القاهرة

ملخص البحث

يعد عظم لوح الكتف من أكثر عظام الهيكل العظمى البشري تنوعاً. ويلعب دوراً رئيسياً فى كفاءة مفصل الكتف. وقد ثبت أن بعض التنوعات هى العامل المسبب الأساسى فى العديد من أمراض الكتف. ومع النقص الملحوظ فى الأبحاث المنشورة التى تناقش تنوع لوح الكتف فى المصريين ، وجد أن القيام بهذه الدراسة ضرورى.

صممت هذه الرسالة لتوضح مدى شيوع التنوعات المورفولوجيه ولتقدير القياسات العظمية لكل من النتوء الأخرومى والشرم فوق اللوح والرباط اللوحى العلوى المستعرض والزاوية الأنسية العلوية وكذلك الحدين الأنسى والوحشى لعظم اللوح.

وفيما يخص النتوء الأخرومى قد تم تقسيمه الى 4 أنواع على حسب انحداره: مسطح , مقعر, خطافى, ومحدب وكان النوع المقعر هو الأكثر شيوعاً ومثل 52% بينما كان النوع المحدب هو الأقل شيوعاً (1%) ويرتبط النوع المقعر والخطافى ارتباطاً وثيقاً بمتلازمة انحشار الكتف وقطع أوتار العضلات المطوقة للكتف, خاصة مع الألعاب الرياضية العنيفة.

وقد تم تحديد 4 أشكال للأخروم وهم اسطوانى مثلث مستطيل ومربع وكان الشكل الإسطوانى هو الأكثر شيوعاً (44%) بينما كان الأقل شيوعاً هو الشكل المربع (8%) . وكان 84% من السطح السفلى للنتوء الأخرومى أملس بينما لوحظ المهماز العظمى فى 16% من الحالات.

وقد أظهر التحليل القياسى للأخروم أن متوسط الطول والعرض 46,6 ± 7,5 و 25,8 ± 3,6مم على التوالى وتم تحديد أبعاد الفراغ تحت الأخروم والقوس الأخرومى الغرابى عن طريق قياس المسافة بين الأخروم وحق اللوح, والأخروم والنتوء الغرابى وكان متوسطهما 30,3 ± 3,9 و 39,4 ± 7,8مم. وقد ثبت أن الضيق الشديد فى هذه المسافات له تأثير مباشر على انحشار مكونات الفراغ تحت الأخروم .

وتم تحديد 4 أشكال مختلفة للشرم فوق اللوح وهى U,V,J والشكل الجديد الذى تم وصفه لأول مرة فى هذه الدراسة وهو على شكل حرف W وكان الشكلUهو الأكثر شيوعاً ووجد فى 41% . كما تم تحديد خمسة أنواع مختلفة للشرم فوق اللوح وهم النوع الأول ويفتقر لوجود شرم واضح والنوع الثانى وهو شرم عريض والنوع الثالث وهو شرم عميق وكان هذا النوع هو الأكثر شيوعاً (43%). والنوع الرابع هو ثقب بدلاً من شرم والنوع الخامس هو شرم فوق ثقب عظم وكان هذا النوع هو الأقل شيوعا)5%).

وبالنسبة للرباط اللوحى المستعرض العلوى كان به تحول عظمى جزئى فى 41% وقد لوحظ هذا التحول الجزئى فى الطرف الأنسى والوحشى ومن كلا الطرفين فى 12%,12%,17% على التوالى ووجد تحول عظمى كامل للرباط في5%من الحالات.

وقد تم تلخيص العوامل العظميه الغير مرضيه لحدوث متلازمة اللوح المطرقع وهم نتوء لوشكا فى الزاويه الأنسية العلوية (42%) ونتوء العضلة المستديره العظمى فى أسفل الحد الوحشى (40%) وكان هذا النتوء له بروز أمامى فى اتجاه القفص الصدرى20% من الحالات وكان الميل الأمامى الخطافى الزائد للجزء أعلى الشوكه من الحد الأنسى قد تم احتسابه عن طريق قياس زاوية الحد الأنسى مقابل جذر شوكة اللوح وكان متوسطها °141,6 ±8,6 .

كما لوحظ 3 أنماط مختلفة للحد الأنسى: محدب ومستقيم ومقعر فى 59%, 30%, 11% على التوالى.

وقد أظهرت دراسة صور الأشعة أن متوسط المؤشر الأخرومى يتراوح بين 0,63 الى 0,71 فى حين تراوحت المسافة بين الأخروم والعضد من 7 الى 14مم وكانت هذه المسافة أقل فى الذكور عنها فى الإناث وكانت أقل على الجانب الأيمن عن الجانب الأيسر وهذه الفروق ذات دلالة إحصائية.

ويمكن للتطبيق العملى لهذين المؤشرين معاً على صور الأشعة التقليدية التوقع بكفاءة بالأشخاص الأكثر عرضه لقطع أوتار العضلات المطوقه للكتف كما انه يمكن الإعتماد عليهما فى تحديد الحالات التى يمكن أن يكون لها نتائج جراحية مرجوه.