Analysis of Anthropometric Measurements of the Scapula in Normal Egyptian Individuals

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Abstract: Background: The osteometric measurements and morphometric knowledge of the scapula is essential to understand and treat different shoulder disorders. **Objective**: The aim of this study is to measure and record the osteometric data of human dried scapula and study the measurements of the scapula in living Egyptian individuals by using radiography. **Material and Method**: This study was carried out on one hundred living human Egyptian individuals of both sexes and one hundred and twenty cadaveric dried human scapulae. The following measurements were obtained; Maximum scapular length (MSL), Maximum scapular width (MSW), Superior-Inferior glenoid diameter, Anterior-Posterior glenoid diameter, Acromion Maximum length (AML) Acromion Maximum breadth (AMB), Length of the coracoid process (LCP), Projection length of scapular spine, Acromio-Coracoid distance, Acromio-Glenoidal distance, Supra-scapular notch Superior transverse diameter, Supra-scapular notch maximal depth, Gleno-polar angle and Glenoid inclination angle. The morphometric parameters were measured and statistically analyzed. **Results:** The study on dried scapula showed that the side has an effect on Acromion Length, but has no effect on scapular Length, Scapular Width, Glenoid superior inferior diameter, Glenoid anterior posterior diameter, Acromion breadth, Coracoid Length, Projection Length of spine, Acromion Coracoid distance, Acromion Glenoid distance, Supra Scapular Notch Superior Transverse diameter, Supra Scapular Notch depth, Glenopolar angle and Glenoid Inclination angle. And this study revealed no statistical significance between the previous parameters measured in dried scapulae and in x-rays. Also there was statistical significance between these scapular measurements and the sex. **Conclusion:** The study presented the normal osteometric values and variations of scapula to understand, treat different shoulder joint disorders, and help in design ing implants for the shoulder joint among Egyptians.

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1. Introduction

The osteometric measurements and morphometric knowledge of the scapula is essential to understand and treat different shoulder disorders. All the components of the scapula have clinical relevance for which the knowledge of the normal anatomy is essential. essential (Lingamdenne and Marapaka, 2016). The glenoid measurements are important to design the glenoid component of the shoulder joint in shoulder arthoplasty and also treatment of glenoid fractures, rotator cuff tears, bony Bankarts lesion, evaluation and management of shoulder joint instability all require precise knowledge of its anatomy (Dirk et al.,2014.) The length and width of the acromion is of paramount importance in the management of rotator cuff tears and impingement syndrome (Anetzberger and Putz, 1996). The length of the coracoid plays an important role in the surgical treatment of coracoid impingement syndrome (Dines et al., 1990). The acromio-coracoid and acromio-glenoid distances have a role in rotator cuff lesions, and impingement syndromes affecting the shoulder and play an important role in their management syndrome (Anetzberger and Putz, 1996). Suprascapular nerve entrapment can occur due to anatomical variations of suprascapular notch, a smaller supra scapular notch could predispose for suprascapular nerve entrapment more than a larger notch (Jacob et al., 2012). Gleno-polar and glenoid inclination angles are important while deciding on the treatment and prognosis of floating shoulder (Kim et al., 2008).

Aim of the work

Measure and record the osteometric data of the human dried scapulae of Egyptians. And to Study the measurements of the scapula in living Egyptian individuals in relation to, sex, side, and length of scapula by using radiography.

2. Material and Method

This study was carried out on100 living human Egyptian individuals of both sex and one hundred and twenty cadaveric dried human scapulae. The individuals were randomly chosen from those coming to Sigma Scan Radiology Center in Giza Governorate of known birth date and sex. Chest x rays were done

for different medical purpose divided into two groups according to sex into (50 male persons and 50 female persons). Scapular radiographs were obtained using standardized protocol of Antro-post imaging with individuals in the supine or erect position with the arm of the side of interest abducted 90 degrees and hand supinated and the center of coracoid process over the center line of the table with person positioned so that the center point of the film is to mid scapular area, which is two inches inferior to coracoid process. The following parameters were obtained; Maximum scapular length (MSL), Maximum scapular width (MSW), Superior-Inferior glenoid diameter, Anterior-Posterior glenoid diameter.

The morphometric parameters were measured using RadiAnt DICOM viewer 4.2.1(64-bit) program then measurements were analyzed statistically in relation to, sex and side of the scapula.

Regarding the cadaveric dried human scapulae, they were collected from the department of Anatomy, Faculty of Medicine Benha University and department of Anatomy, Faculty of Medicine, EL Menofia University.

The measurements were obtained in millimeters with Vernier caliber for linear measurements. Angular measurements were taken using goniometer and protractor.

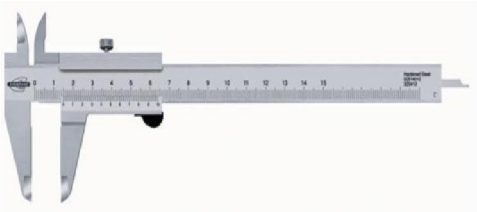

Fig (1) Vernier caliber

As regards the one hundred and twenty dried human scapulae used in this study, The following measurements were obtained; Maximum scapular length (MSL), Maximum scapular width (MSW), Superior-Inferior glenoid diameter, Anterior-Posterior glenoid diameter, Acromion Maximum length (AML) Acromion Maximum breadth (AMB), Length of the coracoid process (LCP), Projection length of scapular spine, Acromio-Coracoid distance, Acromio-Glenoidal distance, Supra-scapular notch Superior transverse diameter, Supra-scapular notch maximal depth, Gleno-polar angle and Glenoid inclination angle.

The morphometric parameters were measured and statistically analysed.

Measurements were compared with respect to the variables right and left using the "t Student", adopting the level of significance ($p < 0.01$) **(Lingamdenne and Marapaka., 2016).**

3. Results

This study was carried out on one hundred and twenty dried human scapulae and one hundred healthy living human Egyptian individuals of both sexes through the radiographs.

(A) Results of the 120 dried human scapulae:-

The study was carried out on 60 right scapulae & 60 left scapulae.

According to the side of human scapula: (Table 1, Histogram 1).

The mean Maximum scapular length (MSL) (Fig.2 & 3), was 150.47±9.92mm in right scapulae, while in left scapulae, it was 150.59±10.19mm. This difference was statistically insignificant. The mean Maximum scapular width (MSW) (Fig.4 & 5) was106.07±5.81mm in right scapulae, while in left scapulae, was 106.27±6.13mm. This difference was statistically insignificant. The mean Glenoid superior inferior diameter (Fig.6 & 7) was 38.39±3.98mm in right scapulae, while in left scapulae, was 38.73±3.24 mm. This difference was statistically insignificant. The mean Glenoid anterior posterior diameter (Fig.6 & 7 was28.49±3.08mm in right scapula, while in left scapulae, was 28.42±2.87mm. This difference was statistically insignificant. The mean Acromion Maximum Length (AML (Fig.4 & 5) was 51.67±1.88mm in right scapula, while in left scapulae, was 52.36±1.61mm. This difference was statistically significant (p value<0.05). The mean Acromion Maximum Breadth (AMB) (Fig.4 & 5) was 31.75±1.02mm in right scapulae, while in left scapulae, was 31.94±1.01mm. This difference was statistically insignificant. The mean Length Coracoid Process (LCP) (Fig.7 & 8) was 42.21±5.20mm in right scapulae, while in left scapulae, was 42.69±5.91mm. This difference was statistically insignificant. The mean Projection length of spin (Fig.4 & 5) was 129.15±11.9mm in right scapula while in left scapulae, was 129.35±12.06mm. This difference was statistically insignificant. The mean of Acromion Coracoid distance (Fig.6 & 7) was 31.02±7.93mm in the right scapulae, while in left scapulae was 31.57±6.28mm. This difference was statistically insignificant. The mean of Acromion glenoid distance (Fig.6 & 7) was 27.12±4.79mm in the right side, while in left scapulae was 27.86±4.43mm. This difference was statistically insignificant. The mean Supra scapular notch superior transverse diameter (Fig.2 & 3) was 9.24±2.17mm in the right scapulae while in left scapulae was 9.57±2.93mm. This difference was statistically insignificant. The mean supra scapular notch depth (Fig. 2 & 3) was 6.09±1.30mm in the right scapulae while in left scapulae was 6.2±1.76mm. This difference was statistically insignificant. The mean Glenopolar angle (Fig. 2 & 3) was 42.1±3.72 degrees

in right scapulae, while in left scapula was 42.33±5.74 degrees. This difference was statistically insignificant.

Therefore the side has an effect on Acromion Length, but has no effect on Scapular Length, Scapular Width, Glenoid superior inferior diameter, Glenoid anterior posterior diameter, Acromion breadth, Coracoid Length, Projection Length of spine, Acromion Coracoid distance, Acromion Glenoid distance, Supra Scapular.

Notch Superior Transverse diameter, Supra Scapular Notch depth, Glenopolar angle and Glenoid Inclination Angle.

Table 1: Shows the normal variables of the Scapulae

Side / Measurements Mm	Right (60)	Left (60)	St t test	P value
Maximum Scapular length	150.47±9.92	150.59±10.19	0.07	0.95
Maximum Scapular width	106.07±5.81	106.27±6.13	0.18	0.86
Glenoid sup-inf diameter	38.39±3.98	38.73±3.24	0.51	0.61
Glenoid ant-post diameter	28.49±3.08	28.42±2.87	0.12	0.90
Acromion length	51.67±1.88	52.36±1.61	2.17	0.032*
Acromion breadth	31.75±1.02	31.94±1.01	1.01	0.32
Coracoid length	42.21±5.2	42.69±5.91	0.47	0.64
Projection length of spine	129.15±11.9	129.35±12.06	0.09	0.93
Acromio-coracoid distance	31.02±7.93	31.57±6.28	0.42	0.68
Acromio-glenoid distance	27.12±4.79	27.86±4.43	0.88	0.38
SSN sup-transverse	9.24±2.17	9.57±2.93	0.71	0.48
SSN maximal length	6.09±1.3	6.2±1.76	0.38	0.71
Gleno-polar angle	42.1±3.72	42.33±5.74	0.26	0.79
Glenoid inclination angle	12.7±3.49	12.8±3.16	0.17	0.87

Maximum Scapular Length (MSL), Maximum Scapular width (MSW), Glenoid Superior-Inferior diameter, Glenoid Anterior-Posterior diameter, Acromion Maximum Length (AML), Acromion Maximum Breadth (AMB), Length of Coracoid Process (LCP), Projection length of scapular spine, Acromio-Coracoid distance, Acromio-Glenoidal distance, Suprascapular Notch superior transverse diameter, Suprascapular Notch maximal depth, Glenopolar angle and Glenoid inclination angle. (comparison between scapular measurements in right and left sides).

Fig (2): A photograph of ventral surface of left scapula showing the following parameters, Maximum Scapular Length (MSL) (FG) is 142 mm, Supra scapular notch superior transverse diameter (TU) is7.9 mm, Supra scapular notch maximum depth (XY) is 8.7 mm and Glenopolar angle (N) is 41.5 degrees

Fig (3): A photograph of ventral surface of right scapula showing the following parameters, Maximum Scapular Length MSL (FG) is 159.9mm, Supra scapular notch superior transverse diameter (TU) is 5.3 mm, Supra scapular notch maximum depth (XY) is 7.4 mm and Glenopolar angle (N) is 38.5 degrees

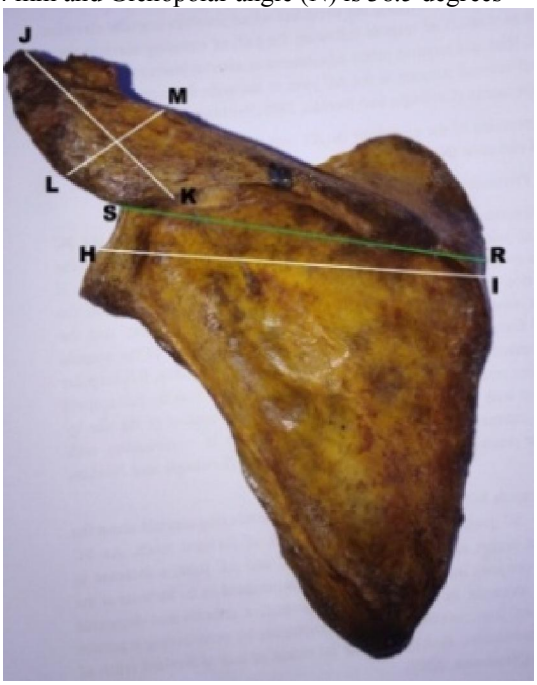

Fig (4): A photograph of dorsal surface of left scapula showing the following parameters, Maximum Scapular Width MSW (HI) is 99.2 mm, Acromion Maximum Length AML (JK) is 47.8 mm, Acromion Maximum Breadth AMB (LM) is 29.7 mm, Projection Length of Scapular Spine (SR) is 108.4 mm.

Fig (5): A photograph of dorsal surface of right scapula showing the following parameters, Maximum Scapular Width MSW (HI) is 108.1 mm, Acromion Maximum Length AML (JK) is 50.2 mm, Acromion Maximum Breadth AMB (LM) is 32.6mm, Projection Length of Scapular Spine (SR) is 125.8 mm.

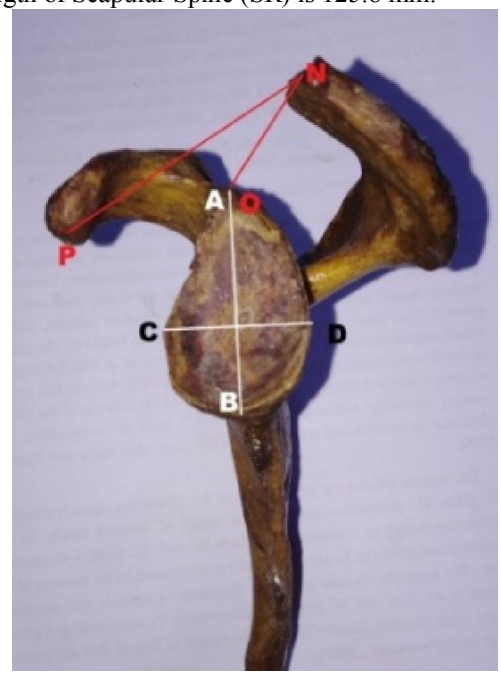

Fig (6): A photograph of lateral aspect of left scapula showing the following parameters, Glenoid Superior Inferior diameter (AB) is 39.1 mm, Glenoid Anterior Posterior diameter (CD) is 25.5 mm, Acromio-Coracoid distance (NP) is 42.7mm, Acromio - Glenoidal distance (NO) is 32.2mm.

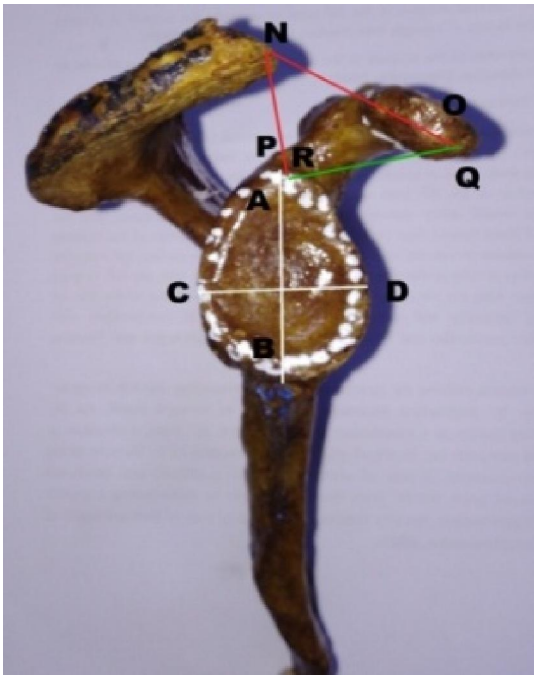

Fig (7): A photograph of lateral aspect of right scapula showing the following parameters, Glenoid Superior Inferior diameter (AB) is 43.8 mm, Glenoid Anterior Posterior diameter (CD) is 30.1 mm, Acromio-Coracoid distance (NO) is 32.1 mm, Acromio–Gle noidal distance (NP) is 27.2 mm, Length of Coracoid Process (QR) is 48.7mm

Fig (8): A photograph of lateral aspect of left scapula showing the following parameters, Length of Coracoid Process (QR) is 42 mm.

(B) Results of the 100 radiographic cases:

According to the sex: (Table 2)

The mean Maximum scapular length (MSL (Fig9 & 11) was 150.52±4.54mm in males while in females, was 143.11±10.27mm. This difference is statistically highly significant (p value < 0.001). The mean Maximum Scapular Width (MSW) (Fig10 & 12). was105.13±6.48mm in males while in females, was 101.45±6.15mm. This difference was statistically highly significant (p value < 0.001). The mean Glenoid Superior –Inferior diameter (Fig9 & 11,) was 38.88±3.35mm in males while in females, was 37.45±3.07mm. This difference was statistically highly significant (p value < 0.001) The mean Glenoid Anterior-Posterior (Fig9 & 11,) diameter was 28.67±3.04mm in male, while in females, was 27.72±3.45mm. This difference was statistically significant (p value < 0.05).

Therefore there was statistical significance between these scapular measurements and the sex.

(C) Comparison between the common measurement between radiological cases and dried scapula

As regards to comparison between dried scapulae and x-rays among left side. (Table 3).

The mean Maximum scapular length (MSL) dried scapulae (Fig2), while in x-ray, (Fig9;11). This difference is statistically insignificant. The mean Maximum Scapular Width (MSW) dried scapulae (Fig4), x-ray, (Fig10; 12). This difference was statistically insignificant. The mean Glenoid Superior –Inferior diameter dried scapulae (Fig6), x-ray (Fig9; 11). This difference was statistically insignificant. The mean Glenoid Anterior-Posterior dried scapulae (Fig6), x-ray (Fig9(Fig9 & 11). This difference was statistically insignificant...

As regards t comparison between dried scapulae and x-rays among right side (Table 4).

The mean Maximum scapular length (MSL) dried scapulae (Fig3), x-ray, (Fig9; 11). This difference is statistically insignificant. The mean Maximum Scapular Width (MSW) dried scapulae (Fig5), x-ray (Fig10;12). This difference was statistically insignificant. The mean Glenoid Superior –Inferior diameter dried scapulae (Fig7), x-rays (Fig9; 11). This difference was statistically insignificant. The mean Glenoid Anterior-Posterior dried scapulae (Fig7), x-ray (Fig9; 11). This difference was statistically insignificant. Therefore this study revealed no statistical significance between the previous parameters measured in dried scapulae and in x-rays.

Table 2. Shows the normal variables of the Scapulae

Sex / Measurements mm	Male (100)	Female (100)	St t test	P value
Maximum Scapular length	150.52± 4.54	143.11± 10.27	6.60	<0.001**
Maximum Scapular width	105.13± 6.48	101.45± 6.15	4.12	<0.001**
Glenoid sup-inf diameter	38.88± 3.35	37.45± 3.07	3.14	0.002**
Glenoid ant-post diameter	28.67± 3.04	27.72± 3.45	2.07	0.04*

Maximum Scapular Length (MSL), Maximum Scapular width (MSW), Glenoid Superior-Inferior diameter and Glenoid Anterior-Posterior diameter (Comparison between scapular measurements in male and female groups)
*=<0.05=significant ** =<0.01 = Highly significant

Table 3. Shows the normal variables of Left scapulae:

Left scapulae				
Measurement mm	**Dried scapulae (60)**	**X-ray (100)**	**St t test**	**P value**
Maximum scapular length	150.59±10.19	147.13±9.5	2.13	0.065
Maximum scapular width	106.27±6.13	103.31±7.53	2.14	0.068
Glenoid sup- inf diameter	38.73±3.24	38.24±3.25	0.93	0.36
Glenoid ant-post diameter	28.42±2.87	28.01±3.52	0.8	0.42

Maximum Scapular Length (MSL), Maximum Scapular Width (MSW), Glenoid Superior-Inferior diameter, Glenoid Anterior-Posterior diameter compared between dried scapulae and x-rays

Table (4). shows the normal variables of right scapulae:

Right scapulae				
Measurement mm	**Dried scapulae (60)**	**X-ray (100)**	**St t test**	**P value**
Maximum scapular length	150.47±9.92	146.5±7.97	2.63	0.06
Maximum scapular width	106.07±5.81	103.27±5.48	3.01	0.063
Glenoid sup- inf diameter	38.39±3.98	37.5±3.19	1.47	0.144
Glenoid ant-post diameter	28.49±3.08	27.81±3.1	1.35	0.18

Maximum Scapular Length (MSL), Maximum Scapular Width (MSW), Glenoid Superior-Inferior diameter, Glenoid Anterior-Posterior diameter compared between dried scapulae and x-rays

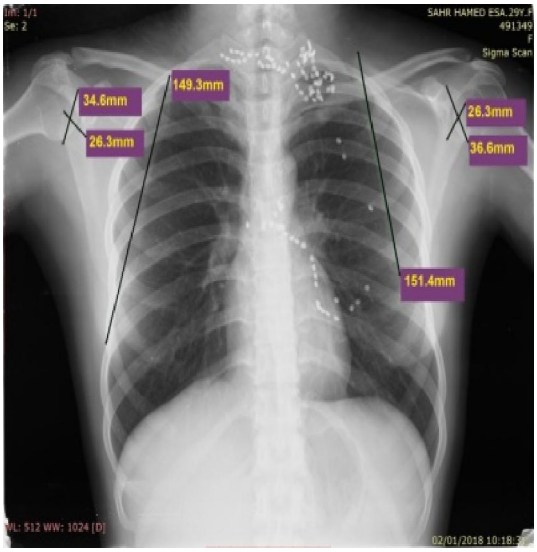

Fig (9): A photograph of plain x-ray of the chest of female aged 29 years showing the parameters of the scapula measured from the anteroposterior roentgenograms of the chest. On left side, Maximum Scapular Length (MSL) is 151.4mm, Glenoid Superior-Inferior diameter is 36.6mm, Glenoid Anterior-Posterior diameter is 26.3mm. on the right side, Maximum Scapular Length (MSL) is 149.3mm, Glenoid Superior-Inferior diameter is 34.6mm, Glenoid Anterior-Posterior diameter is 26.3mm.

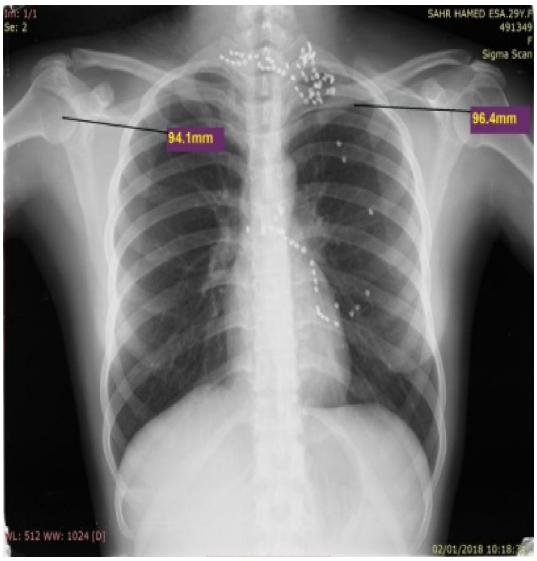

Fig (10): A photograph of plain x-ray of the chest of the previous person showing the parameters of the scapula measured from the anteroposterior roentgenograms of the chest. On left side, Maximum Scapular Width (MSW) is 96.4mm. on the right side Maximum Scapular Width (MSW) is 94.1mm

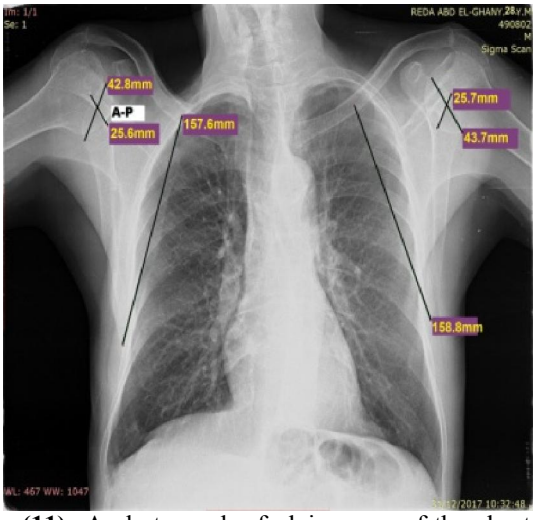

Fig (11): A photograph of plain x-ray of the chest of male aged 28 years showing the parameters of the scapula measured from the anteroposterior roentgenograms of the chest. On left side, Maximum Scapular Length (MSL) is 158.8 mm, Glenoid Superior-Inferior diameter is 43.7 mm, Glenoid Anterior-Posterior diameter is 25.7mm. on the right side, Maximum Scapular Length (MSL) is 157.6 mm, Glenoid Superior-Inferior diameter is 42.8 mm, Glenoid Anterior-Posterior diameter is 25.6 mm

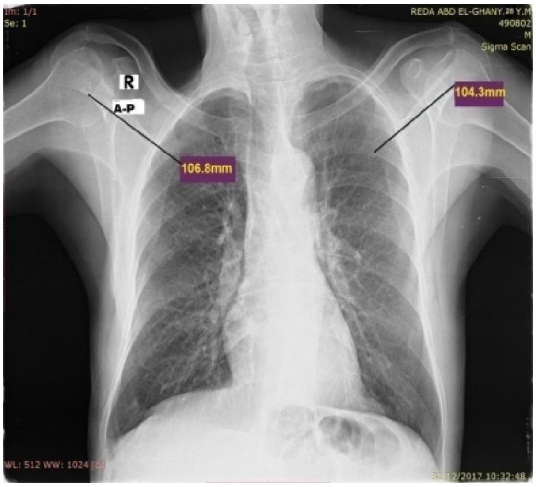

Fig (12): A photograph of plain x-ray of the chest of the previous person showing the parameters of the scapula measured from the anteroposterior roentgenograms of the chest. On left side, The Maximum Scapular Width (MSW) is 104.3mm, on the right side The Maximum Scapular Width (MSW) is 106.8mm.

4. Discussion

The present study dealt with the normal morphometric measurements of the scapula in the dried bones and among the different sex groups on radiographs as well. Also this study evaluated the rule

of scapular morphometry in the management of different shoulder pathologies and in rehabilitation of shoulder injuries.

Regarding the dried bones:

We had recorded morphometric measurements of scapula. We also compared the results between the right and left sides to determine the differences.

The Glenopolar angle (GP) was 42.10°, 42.33°on the right and left sides respectively. The Glenoid Inclination angle was 12.7°, 12.8°on the right and left sides respectively, These Maximum Scapular Length (MSL) to be 150.47, 150.59 mm on the right and left sides. The Maximum Scapular width (MSW) The mean Maximum Scapular width (MSW) was106.07, 106.27 mm on the right and left sides respectively. The Superior-Inferior glenoid diameter The mean Superior-Inferior glenoid diameter was 38.39, 38.73 mm on the right side.

The Anterior-Posterior glenoid diameter. The mean Anterior-Posterior glenoid d The Acromion Maximum Length (AML). The mean Acromion Maximum Length was 51.67mm, 52.36mm on the right and left sides respectively.

The Acromion Maximum Breadth (AMB) The mean Acromion Maximum Breadth (AMB) was 31.75mm,31.94mm on the right and left sides respectively. The Coracoid Length (CL) The mean Coracoid Length (CL) was 42.21mm,42.69mm on the right and left sides respectively. The Projection Length of scapular spine. The mean Projection Length of scapular spine was 129.15mm,129.35mm on the right and left sides respectively. The Acromio coracoid distance. The mean Acromio coracoid distance was 31.02mm,31.57mm on the right and left sides respectively. The Acromio glenoid distance The mean Acromio glenoid distance was 27,12mm,27.86mm on the right and left sides respectively. The Suprascapular Notch Superior transverse diameter. The mean Suprascapular Notch Superior transverse diameter was 9.24mm, 9.57mm on the right and left sides respectively. The Suprascapular Notch Maximal depth The mean Suprascapular Notch Maximal depth was 6.09mm,6.2mm on the right and left sides respectively.

These result are nearly similar to results by Wael Amin et al., (2015). who studied among Egyptians. And also agree with results of Kavita et al., (2013) who studied among Indians.

. But these results differ from that of singh et al., (2013) among Greeks, and from that of Sitha et al., (2004) Among This. Also differ from Paraskevas et al. (2008) among Greeks.

Regarding the radiological cases:

We had recorded the findings of Maximum Scapular Length (MSL), Maximum Scapular width (MSW), Superior-Inferior glenoid diameter and Ant-Post glenoid diameter, among two groups. We also compared the results between right and left sides to determine the differences. The results were compared with previous studies using computed tomography.

Comparison of scapular measurements as regards to the sex

The Maximum Scapular Length (MSL):

In this study the mean of Maximum scapular length (MSL) in males was 150.15 mm in right side in males and 142.84mm in right side for females and it was 150.88mm in the left side in males and 143.37mm in the left side in females. These results were in agreement with the results of El Morsi et al. (2017) who studied among Egyptians also agreed with the results of Torimitsu et al. (2016) who studied among Japanese. But our results differed from the results of Zhang et al. (2016) who studied among Chinese.

The Maximum Scapular Width (MSW):

In this study the mean Maximum Scapular Width (MSW) was105.31 mm in right side in males and 101.23mm in right side for females and it was 104.95mm in the left side in males and 101.66mm in the left side in females. These results were in agreement with the results of El Morsi et al. (2017) who studied among Egyptian, also agreed with the results of Papaioannou et al. (2012) who studied among Greeks.

The Superior Inferior glenoid diameter:

In this study the mean Superior Inferior glenoid diameter in males was 38.88mm and in females was 37.45 mm these results were in agreement with the results of El Morsi et al. (2017) who studied among Egyptians. also agreed with results of Papaioannou et al. (2012) who studied among Greeks and was 38.11mm in males and 33.52 mm in females. Torimitsu et al. (2015) who studied among Japanese recorded the smallest results, it was 33.73m6) who studied among Chinese.

The Anterior Posterior glenoid diameter

In this study the mean Anterior Posterior glenoid diameter in males was 28.67mm and in females was 27.72 mm these results were in agreement with the results of El Morsi et al., (2017) who studied among Egyptians, also agreed with results of Papaioannou et al. (2012) who studied among Greeks.

Therefore the results of this study state that males have bigger diameters than females indicating sexual dimorphism of scapula. This study also demonstrated that the scapula is bilaterally symmetrical.

Knowledge of the normal osteometric values and variations of scapula is important to understand, treat different shoulder joint disorders, and help in designing implants for the shoulder joint and rehabilitation of players who sustained Scapular sports injuries. Lingamdenne and Marapaka. (2016)

References

1. Anetzberger, H. and Putz, R. (1996). The scapula: principles of construction and stress. Acta Anatomica 156: 70–80.
2. Dines, D.M. Warren, R.F. Allan, E. Inglis. (1990). The coracoid impingement syndrome. The journal of bone and joint surgery. 72- B:314-316.
3. Dirk, P.H. Van Oostveen, Olivier, P.P. (2014). Glenoid fractures. A review of pathology, classification, treatment and results. Acta Orthop. Belg., 80:88-98.
4. El Morsi, D.A. Gaballah, G. Mahmoud, W. Tawfik, A.I. (2017). Sex Determination in Egyptian Population from Scapula by Computed Tomography. J Forensic Res 8: 376.
5. Jacob, P.J. Arun, K. and Binoj, R. (2012). Suprascapular Nerve Entrapment Syndrome. Kerala journal of orthopaedics25:21-24.
6. Kavita, P. Jaskaran, S. Geeta. (2013). Morphology of coracoid process and glenoid cavity in adult human Scapulae. International Journal of Analytical, pharmaceutical and Biomedical Sciences. 2(2):19-22.
7. Kim, K.C. Rhee, K.J. and Shin, H.D. (2008). Can the glenopolar angle be used to predict outcome and treatment of the floating shoulder? J Trauma. 64(1):174- 178.
8. Lingamdenne, P.E and Marapaka, P. (2016). Measurement and analysis of anthropometric measurements of the Human scapula in telangana region, india. Int j anat res;4(3):2683.
9. Papaioannou, V.A. Kranioti, E.F. Joveneaux, P. Nathena, D. and Michalodimitrakis, M. (2012). Sexual dimorphism of the scapula and the clavicle in a contemporary Greek population: applications in forensic identification. Forensic Science International 217: 231.e1–231.e7. V. A.
10. Paraskevas, G. Tzaveas, A. Papaziogas, B. Kitsoulis, P. Natsis, K. Spanidou1, S. (2008). Morphological parameters of the acromion. Folia Morphol. 67:255–60.
11. Singh, J. Pahuja, K. Agarwal, R. (2013). Morphometric parameters of the acromion process in adult human scapulae. Indian J Bas Appl Med Res 8(2):1165-70.
12. Torimitsu, S. Y. Makino, H. Saitoh, A. Sakuma, N. Ishii, M. Hayakawa, G. Inokuchi, A. Motomura, F. Chiba, Y. Hoshioka, H. Iwase, (2015). Stature estimation in Japanese cadavers based on scapular measurements using multidetector computed tomography, Int. J. Leg. Med. 129: 211–218.
13. Wael Amin, N.E. Mona, H.M.A. (2015).A Morphometric Study of the Patterns and Variations of the Acromion and Glenoid Cavity of the Scapulae in Egyptian Population. Journal of Clinical and Diagnostic Research.Aug;9(8): AC08-AC11.
14. Zhang, K. Cui, J.H. Luo, Y.Z. Fan, F. Yang, M. Li, X.H. Zhang, W. Deng, Z.H. (2016). Estimation of stature and sex from scapular measurements by three-dimensional volume-rendering technique using in Chinese. Legal Medicine 21:58-63.

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