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Original Research Article

MORPHOMETRY OF GLENOID USING DIGITAL PHOTOGRAPHS AND IMAGE PROCESSING SOFTWARE

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ABSTRACT

Background: A good understanding of morphometry of glenoid cavity of the scapulae is essential for proper designing of glenoid prosthesis. Moreover the anatomical basis and variations of shape and size of glenoid cavity of scapula is of fundamental importance in understanding of rotator cuff disease, shoulder dislocation and to decide the proper size of the glenoid component in the shoulder arthroplasty. Digital photography has become an essential tool in modern medicine which has great potential for medical researches. In medical field technology has grown so much that computer based measurement are highly accurate and important for designing various prosthesis.With this background our aim was to do the study of measurements of the glenoid cavity by using digital photographs, Microsoft powerpoint 2007 and Image J, an image processing and analysing software.

Materials and Methods: Glenoid cavity of two hundred scapulae (100-right and 100-left), were photographed along with scale using digital camera. These photos were transferred to the computer and required lines were drawn using Microsoft ppt for measurements of length and width of the glenoid. Image J software was used for measuring the parameters and analysis done by SPSSversion 16.

Results: The mean length of glenoid on the right side was 3.55 cm and the width was 2.30 cm whereas the mean length of glenoid on the left was 3.59 and the width was 2.41cm. The mean value of glenoid index on right side was 66.89±9.71 and on the left side was 67.99±8.03. On comparing the right and left side there was a significant difference in the width ($p<0.05$) but no significant difference in the length and glenoid index

Conclusion: In our study, we conclude that the values of glenoid parameters can be easily obtained by using photos and Image J which are comparable to other studies where measurements were done routinely with vernier calipers. There was significant difference between right and left side in the width of the glenoid The digital photographs and software technologies can be used in other anthropometric researches which make them faster and easier .

KEY WORDS: Glenoid Morphometry, Imaje j, Glenoid fossa, Glenoid index.

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INTRODUCTION

The shoulder joint is the most dynamic joint in the body. Limitation of this joint movements affects the quality of life. End stage glenohumeral arthritis or severe shoulder injury causes shoulder dysfunction with potentially devasting results. To restore normal functions orthopedicians replace the diseased shoulder

with a total shoulder arthroplasty, or reverse shoulder prosthesis, or hemiarthroplasty. The long term success of arthroplasty depends on the design of the prosthesis and its fixation to the bone [1]. The most common problem of joint replacements is loosening .This problem is accentuated in the glenoid prosthesis fixation because of the orientation of the glenoid articular surface and relatively small area of the glenoid. A good understanding of the morphometry of glenoid cavity is essential for designing the prosthesis [2].

Anatomic parameters of the glenoid relevant to prosthesis design include glenoid height, width, glenoid index, articular surface area, inclination, vault size and shape, and version. Studies have demonstrated considerable natural variability in these parameters; these variabilities affect prosthesis design, instrumentation, and intraoperative implantation techniques [3]. The anatomical basis and variations of shape and size of glenoid cavity of scapula is of fundamental importance in understanding of rotator cuff disease, shoulder dislocation and to decide the proper size of the glenoid component in the shoulder arthroplasty [4]which emphasizes the importance of the morphometry of glenoid.

We are in the Digital photography era where in everything is digitalized. Digital photography has become an essential tool in modern medicine [5]. Images and videos are currently used across most areas of medicine where visual pathology requires documentation and they have great potential for medical use and researches [6]. Digital photography has simplified the process of capturing and utilizing digital images for health care professionals [7]. In particular the evolution of technologies have enabled digital photography to become a vital component of teaching and learning in the health care setting[8,9]. In our study the same has been used for research purpose. Our time, energy and distance can be reduced if we can use digital photos for various anthropometric measurements in Anatomy, Forensic medicine and orthopaedics.

The computer based approach is highly beneficial for analyzing the morphology of scapula especially the glenoid [2].The method of computer based measurement were non destructive and highly accurate and important for designing the glenoid prosthesis [1,10].

Inspite of various studies on morphometry of glenoid, the aim of this study was to evaluate the study of measurements of the glenoid cavity by using digital photographs, Microsoft powerpoint 2007 and Image J software.

The objectives were 1. To estimate length and breadth of the right and left glenoid cavities and thereby glenoid index with the help of Image J, using digital photographs 2. To estimate the differences in these parameter in left and right glenoid cavity.

MATERIALS AND METHODS

Two hundred dry scapulae of 100 Right (Rt) and 100 Left (Lt) were randomly selected from the Department of Anatomy in St.John's Medical college Bangalore. The scapulae damaged at the glenoidal end and ones showing obvious pathology like healed fractures were not included in the study. We adapted an innovative easy method of taking digital photos of glenoid cavity with a scale using CANON camera and analysing the length and breadth with ImageJ, an image processing and analysing software.

Glenoid length or height is defined as the distance from the most superior point on the glenoid to the most inferior point. Glenoid width is defined as the distance from the most anterior point on the glenoid to the most posterior point [11]. The scapulae placed on osteometric board with scale & photograph of glenoid taken. The picture captured thus, was transferred to the computer and then picture was rotated, lines to be drawn connecting Cranial point (A), caudal point (B) of glenoid cavity and then another line connecting posterior (C), anterior most points (D) drawn (as in Fig.1)using Microsoft Power Point 2007 software. Image J software is used for measuring the length and width of the glenoid cavity

Glenoidal index is calculated through the following equation [11]:

glenoid width/glenoid length × 100.

SPSS version 16 was used to calculate the range, mean, standard deviation of both glenoid diameters

and the glenoid index of both right and left side. Independent sample t-test was used to compare the datas of right and left side.

RESULTS

Table1: Mean values of the length of glenoid cavity using Image J.

S.no	Side	No.of bones	Mean±SD (cm)	Minimum (cm)	Maximum (cm)
1	Right	100	3.55 ± 0.52	2.5	5
2	Left	100	3.59 ± 0.77	2.38	5.25

Table 2: Mean values of the width of glenoid cavity using Image j.

S.no	Side	No.of bones	Mean±SD (cm)	Minimum (cm)	Maximum (cm)
1	Right	100	2.30 ± 0.22	1.75	2.88
2	Left	100	2.41 ± 0.45	1.63	3.5

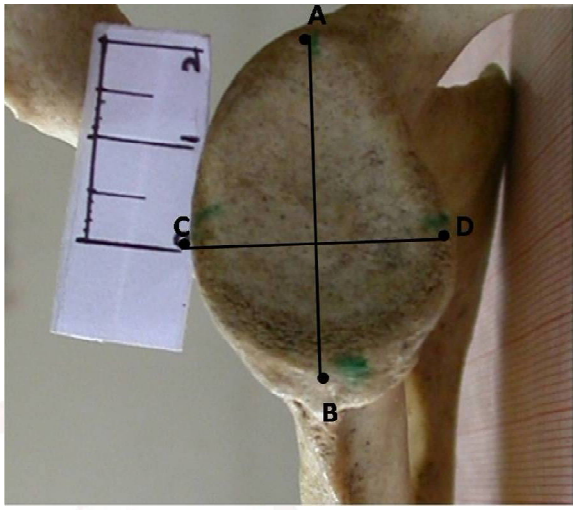
Table 3: Comparision of glenoid cavity parameters with other studies. [2,11-17, 22,23].

S.no	Author	Methodology	Sample size	Length (mm)	Width (mm)
1	Gamal Hamed (2015) Egyptian	dry bone Vernier callipers	Right-38	33.1 ± 3.9	24.4 ± 4.4
			Left-30	28.7 ± 4.1	22.1 ± 4.4
2	Neeta Chhabra (2015) Indian	dry bone Vernier callipers	Right-55	38.46 ± 2.81	25.04 ± 2.69
			Left-71	39.03 ± 3.18	24.85 ± 2.46
3	Ajay kumar (2015) Indian	Dry bones using Vernier caliper	80		
			Right	36.2 ± 1.7	24.2 ± 1.3
			Left	33.2 ± 1.8	22.5 ± 1.4
4	Gosavi S.N (2014)	Dry bones using Vernier caliper	Right-62	35.03 ± 5.25	24.17 ± 2.57
			Left-80	35.3 ± 3.41	23.9 ± 2.66
5	Girish V.Patil (2014)	Dry bones using Vernier caliper	Right-104	33.68±4.32	23.29±2.34
			Left-120	32.09±4.11	24.90±2.95
6	Pahuja Kavita (2013)	Dry bones using Vernier caliper	Right-67	35.2±3.0	25.0±2.7
			Left-62	34.7±2.8	24.9±2.4
7	Mamatha (2009)	Dry bones using Vernier caliper	Right-98	33.67±2.82	23.35±2.04
			Left-104	33.92±2.87	23.02±2.30
8	Coskun N (2006) Turkish	Dry bone-Xray	90	36.3±3	24.6 ± 2.5
9	Churchill (2001)	Bone	344	37.5-men	27.8-men
				32.6-women	23.6-women
10	Present authors Bangalore India	Dry bones using Vernier caliper	Rt-100	34.34 ± 3.11	23.91 ± 2.48
			Lt-100	34.62 ± 3.21	24.59 ± 2.49
11	**Present study Bangalore India**	**Dry bone using digital photography and imaje J**	**Rt-100**	**35.5 ± 5.2**	**23.0 ±2.2**
			Lt-100	**35.9 ±7.7**	**24.1 ± 4.5**

The mean values of the length and breadth of the glenoid cavities are tabulated above Table1 & Table 2 respectively. The mean length of glenoid on the right side was 3.55 cm and the width was 2.30 cm whereas the mean length of glenoid on the left was 3.59 cm and the width was 2.41cm. The mean value of glenoid index on right side was 66.89±9.71 and on the left side was 67.99±8.03.

On comparing the lengths of right and left side glenoid cavities using independent sample t-test there wasn't a significant difference (p value 0.66) whereas on comparing the widths there was a significant difference with the p value of 0.02 (ie.,< 0.05). On comparing the glenoid cavity index of both Rt and Lt there was no significant difference.

Fig. 1: Method of drawing lines for measurenents using Microsoft Power Point (Right side Glenoid).



AB: line connecting A&B-the length of glenoid; **CD:** line connecting C&D-the width of glenoid.

DISCUSSION

The results of our study done using digital photographs of glenoid cavity and Image J for measurements is comparable with other Indian studies done using the traditional way of measuring the parameters with Digital vernier caliper (Table 3). The advantage of using this methodology are 1. The manual work of measuring the parameters for various studies can be replaced with computer software after taking digital photos –both time and energy are saved. 2. When we want to increase the sample size rather than travelling so much of distance the photos can be taken with scale and sent through internet for analysis [3]. Once photos are clicked and transferred to the computer, the parameters can be analysed wherever and whenever possible i.e., not restricted by place.4. Researches become easy with use of these technologies

Gamel Hamed studied 68 dry glenoid fossa of Egyptian population and found that the length of the glenoid fossa on the right and left scapulae was 3.31 and 2.87cm respectively with the values in right more than left [11].

Neeta chabbra (38.46mm-Rt, 39.03mm – Lt)[12]

and Gosavi (35.03mm –Rt, 35.3mm-Lt)[13] also got similar results like that of our study with slightly increased length of glenoid cavity in left side compared to right side but unlike our study in these studies the width of the glenoid were more on the right . Mamatha et al [14] has also reported higher values for length in the left side (as shown in the Table3).

Patil [15] in his study of 224 scapulae reported the widths of left side to be slightly more than right side(23.29cm-Rt,24.90cm-Lt) like our study. In western studies of Churchil [16], he reported Length (37.5-men, 32.6-women) and width (27.8-men & 23.6-women), to be higher compared to Indian population. Coskun et al [17] in Turkish population, reported a mean vertical length of the glenoid cavity of 36.3, which is slightly more higher.

H.R. Hoenecke J [18] demonstrated the maximum wear and tear lies posteriorly in the 8'o clock and 9'o clock position and many studies correlate the posterior glenoid wear in osteoarthritis with increased glenoid retroversion [19]. Hence we could explain that the decrease in parameters on the right side could be due to wear and tear phenomenon as most of the population are right handed. As part of our thesis [2] we have done the glenoid cavity measurements with vernier caliper also and found the measurements are comparable to our image J values. We have got a significant difference in the width between right and left glenoid with the p value of 0.02 (ie.,< 0.05).

Dhindsa singh [20] reported the average glenoid cavity index (CGI) on the right to be 70.37 ± 4.08 and that of left to be 68.59 ± 4.36 whereas Polguj M et al [21] noted the combined GCI to be 72.35±5.55. In Egyptian population Hamed reported glenoid index [11] of the right and left scapulae to be 73.67 and 76.71 respectively. On comparing with these studies our glenoid index values are lesser(66.89-Rt and 67.99–Lt). This difference can be attributed to study population [16].

Knowledge of the dimensions of the glenoid and understanding of variations in normal anatomy of the glenoid is essential even in evaluating pathological conditions like osseous bankart lesions and osteochondral defects [4].

If digital photos of the glenoid and imageJ can be used for these then it will be of great use in Anatomy. Similarly for other anthropometric and osteology studies digital photographs can be utilized which is easier and faster.

These digital studies require basic computer skills and photographic skills and the limitation of our study is scapulae were not sexed for comparison.

CONCLUSION

In our study after analyzing 200 dry scapulae using digital photographs and ImageJ we conclude that the values of glenoid parameters obtained are comparable to other studies where measurements were done with vernier calipers. There was a significant difference between right and left side in the width of the glenoid but no significant difference in length and glenoidal index between right and left scapulae. The right sided values are slightly lower,probably due to osteoarthritic glenoid wear and tear due to right handedness in majority of population. Glenoid prosthesis to be designed to suit the morphometry of that population to increase the biomechanical activity of shoulder.

We suggest from our study that other osteological , anthropometric and orthopaedic studies can also be done easily and accurately with digital photos and image analyzing software

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Conflicts of Interests: None

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