Anatomical Variants

MORPHOMETRIC PARAMETERS OF THE GLENOID FOSSA WITH THE LABRUM ATTACHED

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RESUMEN

La altura y la anchura de la cavidad glenoidea es importante en el reemplazo total de hombro. Estudios previos, utilizando diferentes métodos, han presentado diferencias respecto a la altura y a la anchura de la cavidad glenoidea. El presente estudio tiene como objetivo proporcionar los parámetros morfométricos de la fosa glenoidea con el labrum incluido. Materiales y métodos: Se disecaron y tomaron medidas de ciento cuarenta hombros pertenecientes a 30 varones y 40 mujeres. La cavidad glenoidea se expuso con el labrum incluido y seguido de la medición directa de la altura de la cavidad glenoidea, la anchura y el nivel de máxima anchura usando calibres digitales. Los datos tuvieron doble entrada en el Paquete Estadístico para Ciencias Sociales (SPSS, versión 21). Se utilizaron Kruskal - Wallis y análisis de varianza de una sola vía en las pruebas de filas. La significancia estadística se definió como p<0,05. Resultados: Los valores de la altura, anchura y altura a la anchura máxima media para ambos sexos fueron: 38,94 mm, 30,50 mm y 17,14 mm, respectivamente. Sin embargo, la altura media, anchura y nivel de anchura máxima fueron significativamente mayores en los hombres que en las mujeres (p< 0,001 para cada uno). Conclusiones: La altura media, anchura y el nivel de máxima anchura con el labrum glenoideo incluido fueron significativamente mayores en hombres que en mujeres. Esto sugiere que el aumento de la altura y la anchura se debe a que el labrum glenoideo es proporcional a la altura y la anchura de la cavidad glenoidea, teniendo en cuenta la diferencia de los resultados tomados entre varones y mujeres, con o sin el labrum glenoideo incluido.

Palabras clave: *Altura de la cavidad glenoidea; Anchura de la cavidad glenoidea; Escápula.*

ABSTRACT

Background: The height and width of the glenoid fossa is important in total shoulder replacement. Previous studies, using different methods, have reported differences in glenoid fossa height and width. The current study aims to provide the morphometric parameters of the glenoid fossa with the labrum attached. Material and Methods: One hundred and forty shoulders from 30 males and 40 females were dissected and measurements taken. Exposure of the glenoid fossa with the labrum attached was undertaken, followed by direct measurement of glenoid height, width and level of maximum width using digital calipers. Data were double-entered into the Statistical Package for Social Sciences (SPSS, version 21). Kruskal-Wallis and One Way Analysis of Variance on Ranks test were used. Statistical significance was defined as p<0.05. Results: The overall mean height, width and the level of maximum width for both genders were 38.94 mm, 30.50 mm and 17.14 mm respectively. However, the mean height, width and level of maximum width were significantly greater in males than females (P<0.001 for each). Conclusion: The mean height, width and the level of maximum width with the glenoid labrum attached were significantly greater in males than females. It suggests that the increase in height and width is due to the glenoid labrum is proportionate to the height and width of the glenoid fossa thus accounting for the difference between males and females remaining significant with or without the glenoid labrum.

Keywords: *Glenoid fossa height; Glenoid fossa width; Scapula.*

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INTRODUCTION

Glenoid height is the distance between the most superior and inferior points on the glenoid fossa. Based on gender, side and the methodology used mean glenoid height is variable (Table 1). Nevertheless, glenoid height is reported to be greater in males than females, with the difference being significant in some studies (Mallon et al, 1992; Churchill et al, 2001; Checroun et al, 2002; Merrill et al, 2009), but not in others (Iannotti et al, 1992). No difference in glenoid height has been reported between different races (Churchill et al, 2001; Merrill et al, 2009). Kwon et al (2005) reported that measurements taken directly from bone compared to those taken from 3-dimensional computed tomography scans (3D CT scans) were smaller and concluded that measurements from 3D CT scans were accurate and could be used in the preoperative evaluation of the glenoid fossa.

Glenoid width is the distance between the most anterior and posterior points on the glenoid fossa. Based on gender, side and the methodology used mean glenoid width also appears to be variable (Table 1). Not surprisingly the mean width of the lower half of the glenoid fossa is greater than the upper half with a ratio of 1:0.80±0.01 (Iannotti et al, 1992). Significant differences in width between genders have been reported by Mallon et al (1992), Churchill et al (2001), Checroun et al (2002) and Merrill et al (2009), but not between races (Churchill et al 2001; Merrill et al, 2009). De Wilde et al (2004) reported a correlation between glenoid height and width (r=0.77).

Previous studies have tended to measure glenoid height and width directly from the scapula or from CT scans. Accurate measurement of the glenoid fossa is critical in glenohumeral joint arthroplasty; furthermore, the glenoid labrum plays an important role in glenohumeral joint stability by increasing the surface area of the articular surface. The current study aims to provide morphometric parameters of the glenoid fossa with the labrum attached.

Study	No	Method	Mean height (range)	Mean width (range)
Mallon et al (1992)	28	Scapulae	M: 38 (43 – 45) F: 36.2 (33 – 45)	M:28.3 (24 – 32) F: 23.6 (17 – 27)
Iannotti et al (1992)	140	Patients & scapulae	39 (30 – 48)	-
Churchill et al (2001)	172	Scapulae	M: 37.5 (30.4 – 42.6) F: 32.6 (29.4 – 37)	M: 27.8 (24.3 – 32.5) F: 23.6 (19.7 – 26.3)
Checroun et al (2002)	412	Scapulae	37.9 (31.2 – 50.1)	29.3 (22.6 – 41.5)
De Wilde et al (2004)	98	Scapulae	35.6	25.8
Kwon et al (2005)	12	Scapulae 3D CT scans	37.8 (30 – 47) 39.1 (31 – 48)	26.8 (22 – 35) 25.2 (21 – 34)
Bicknell et al (2007)	72	Scapulae	41 ± 6.1	22.9 ± 4.6
Codsi et al (2008)	11	Scapulae	35 (33 – 45)	-

Table 1- Comparison of glenoid height and width (mm) in different studies; M: males; F: females; Nº: number.

MATERIAL AND METHODS

One hundred and forty shoulders from 30 males and 40 females Caucasian cadavers (average age 81.5 years: range 53–101 years) were dissected and examined.

All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous joint capsule, were removed allowing full exposure of the glenoid fossa with the glenoid labrum still attached.

Using a digital caliper, the maximum distance between the most superior and inferior aspects of the glenoid labrum was considered as glenoid height; while the maximum distance between the most anterior and posterior points of the glenoid labrum was considered as glenoid width. Maximum width was determined by measuring the distance between the mid-point of the maximum width and the most inferior point of the glenoid labrum (Figure 1).

Data were double-entered into the Statistical Package for Social Sciences (SPSS, version 21). Kruskal-Wallis and One Way Analysis of Variance on Ranks tests were used. Statistical significance was defined as $p<0.05$. The

repeatability and reliability of the taken measurement was determined by randomly selecting shoulders from the study cohort. Three measurements were taken on a three separate occasions by the researcher and by two other individuals on two separate occasions.

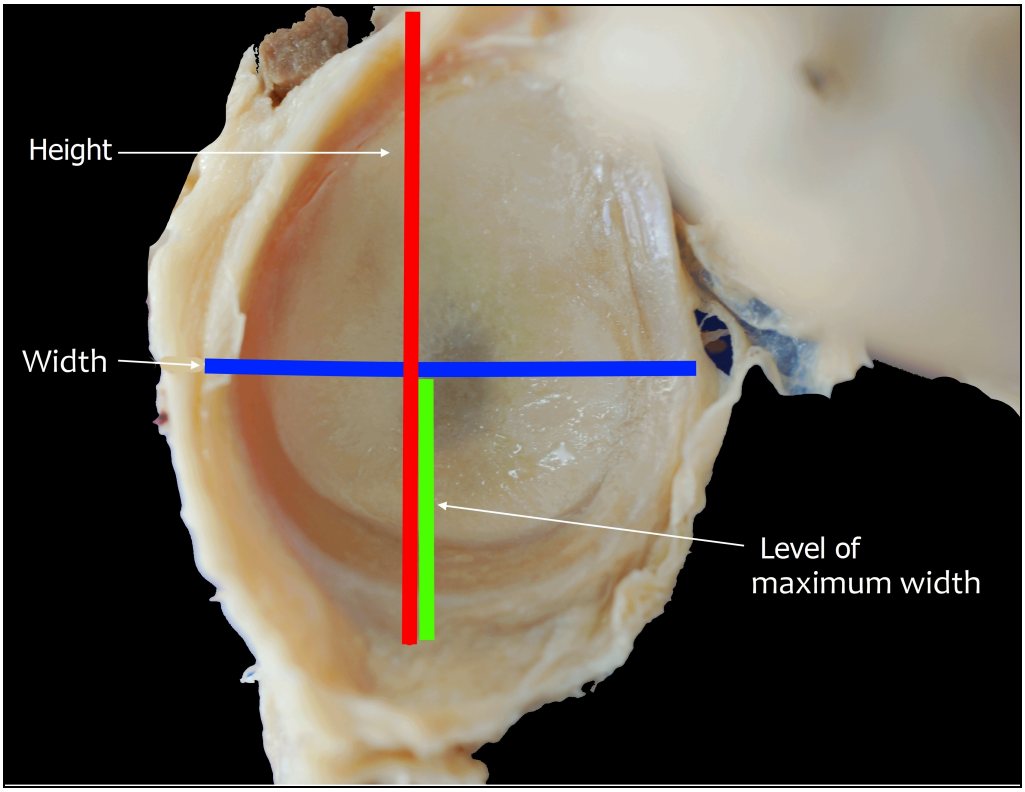

Figure 1- Measurement of the glenoid fossa with the glenoid labrum attached.

RESULTS

One Way Analysis of Variance on Ranks showed there were no intra or inter-observer differences in measurements taken, suggesting that the measurement methodology used was reliable and repeatable.

The overall mean height, width and level of maximum width were 38.94 mm, 30.50 mm and 17.14 mm, respectively. However, when considered separately the mean height, width and level of maximum width were all significantly greater in males than females ($P<0.001$ for each). In both genders there was no significant side to side difference in all measured parameters (Table 2).

DISCUSSION

The height of the glenoid fossa reported in the literature varies. While the current observations respect to glenoid height in males is similar to previous reports, it is distinctly different in females (Mallon et al, 1992; Churchill et al, 2001; Checroun et al, 2002; Merrill et al, 2009). The current study also supports earlier observations that glenoid height is greater in males than females (Mallon et al, 1992; Churchill et al, 2001; Merrill et al, 2009), with the glenoid labrum attacged being 42.21 mm and 36.63 mm respectively. The glenoid labrum therefore increases glenoid height and as such increases the articular surface area thus enhancing joint stability. The significant difference in glenoid height between males and females with the labrum attached suggests that the thickness of the labrum is proportionate to the height of the glenoid fossa.

It can be argued that glenoid height could be affected by degenerative diseases; however, Bicknell et al (2007) found that mean glenoid height showed no difference with respect to osteoarthritis or gender. One criticism concerns the potential difference in the measurement of

glenoid height between cadavers and living patients; however, Iannotti et al (1992) reported no difference between patients and cadavers.
With regards to glenoid width, Mellon et al (1992), Churchill et al (2001) and Merrill et al (2009) all report similar mean values in males and females, being 28.3 mm and 23.6 mm, 27.8 mm and 23.6 mm and 28.56 mm and 23.67 mm, respectively, with width being significantly wider in males (Mallon et al, 1992; Churchill et al, 2001; Checroun et al, 2002; Merrill et al, 2009). According to Iannotti et al (1992) mean glenoid width of the lower half of the fossa is 29 mm (range 21–35 mm): the width of the lower half tends to be larger because the glenoid tends to be pear-shaped. The current study found that the mean width of the glenoid fossa, including the glenoid labrum, in males and females was 33.27 mm and 28.53 mm respectively, being significantly wider in males. Compared to previous studies, it is clear that the glenoid labrum also increases the surface area of the articular surface transversely again enhancing joint stability. The mean level of maximum width in males and females was 18.84 mm and 15.94 mm respectively, being significantly different between genders. As the level of maximum width in males and females is less than half the mean overall height of the glenoid this emphasizes the glenoid fossa as being pear-shaped or oval rather than rounded.

Descriptive statistics	Mean (mm)	Range (mm)	Standard deviation (mm)
Both genders			
H	38.94	32.7 – 46.07	3.41
W	30.50	23.03 – 36.82	3.16
LW	17.14	12.99 – 23.66	2.06
Females both sides			
H	□ 36.63	32.70 – 41.01	1.97
W	□ 28.53	23.03 – 33.81	2.37
LW	□ 15.94	12.99 – 19.24	1.39
Right side females			
H	36.73	32.7 – 41.01	2.03
W	28.49	23.03 – 33.15	3.43
LW	15.92	12.99 – 19.24	1.50
Left side females			
H	36.52	32.91 – 39.99	1.93
W	28.56	24.03 – 33.81	2.34
LW	15.92	13.26 – 18.87	1.27
Males both sides			
H	□ 42.21	37.62 – 46.07	2.07
W	□ 33.27	30 – 36.82	2.72
LW	□ 18.84	16.11 – 23.66	1.62
Right side males			
H	42.59	37.97 – 46.07	2.15
W	33.13	30 – 36.82	1.68
LW	18.89	16.69 – 23.66	1.83
Left side males			
H	41.53	34.48 – 45.05	2.37
W	32.89	20.37 – 36.67	3.07
LW	18.74	16.11 – 21.6	1.40

Table 2- Measurements of the glenoid fossa parameters in both genders; H: height; W: width; LW: Level at maximum width.
□ Measured parameters are significantly different.

In summary the mean height, width and level of maximum width of the glenoid fossa with the labrum attached were 38.94 mm, 30.50 mm and 17.14 mm respectively, being significantly greater in males than females (P<0.001 for each). Compared to previous studies, the current study

suggests that the increase in height and width provided by the glenoid labrum is proportionate to its height and width, thus accounting for why the difference between males and females remains irrespective of whether the glenoid labrum is present or not. The current study also supports the concept that the glenoid labrum provides stability to the glenohumeral joint by increasing the articular surface area. It is suggested that further research should be conducted to improve prosthetic glenoid design and fixation in total shoulder arthroplasty.

Conflict of interest
None of the authors has any conflict of interest.

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Ethical Approval, Informed Consent
All the cadavers were studied under the regulations in Human tissue (Scotland) Act 2006

Contributions
A.A. and A.A.: data collection, data analysis and writing-up. R.S.: data analysis and supervision.

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