Original Communications

THE GLENOID NOTCH AND ITS CLINICAL IMPLICATIONS

Abduelmenem Alashkham[1,2,3], Abdulrahman Alraddadi[1,4], Roger Soames[1]

[1]Centre for Anatomy and Human Identification, University of Dundee, Dundee. United Kingdom
[2]Human Anatomy Department, Faculty of Medicine, University of Zawia, Zawia, Libya.
[3]Centre for Human Anatomy, School of Biomedical Sciences, University of Edinburgh, Edinburgh, United Kingdom
[4]King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

RESUMEN

A menudo se observa una muesca en el lado anterosuperior de la fosa glenoidea, sin embargo su relación con el sexo sigue siendo inexplorada. Los objetivos de este estudio fueron: (i) investigar la incidencia y el tipo de muesca glenoidea, y (ii) su relación con el sexo, la edad y el lado en el que se observa. Se examinaron un total de 140 hombros de entre 30 cadáveres masculinos y 40 femeninos. Todos los músculos y vasos sanguíneos que rodean la articulación glenohumeral, así como la cápsula fibrosa, fueron retirados para permitir el acceso a la fosa glenoidea: la presencia de la muesca fue clasificada como tipo I (leve), tipo II (moderado) o tipo III (grave). La edad media de los especímenes examinados fue de 81,5 años (± 9,8 años). La muesca de tipo III fue la más comúnmente observada (32 varones, 21 mujeres), seguida por la muesca de tipo I (14 varones, 34 mujeres) y finalmente seguida de la de tipo II (14 varones, 25 mujeres). El análisis multivariado mostró que el tipo de muesca glenoidea está significativamente relacionado con el sexo ($\chi 2$ (2 n=140)=11,088, p=0,004). Las mujeres son significativamente más propensas a presentar una muesca glenoidea de tipo I o II, mientras que los varones son significativamente más propensos a presentar una muesca de tipo III. Esta diferencia podría explicar la mayor incidencia de luxación de hombro que se produce en los varones en comparación con la que se produce en las mujeres.

Palabras clave: *Muesca glenoidea; Fosa glenoidea; Articulación glenohumeral.*

ABSTRACT

A notch is often observed on the anterosuperior aspect of the glenoid fossa, however its association with gender remains unexplored. The aims of this study were to: (i) investigate the incidence and type of glenoid notch, and (ii) its association with gender, age and side. A total of 140 shoulders from 30 male and 40 female cadavers were examined. All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous capsule, were removed to expose the glenoid fossa: the presence of a notch was classified as type I (mild), type II (moderate) or type III (severe). The mean age of specimens was 81.5 years (±9.8 years). A type III notch was the most commonly observed (32 male, 21 female specimens), followed by type I (14 male, 34 female specimens) and finally type II (14 male, 25 female specimens). Multivariate analysis showed that the type of glenoid notch was significantly associated with gender ($\chi 2$ (2, n=140) = 11.088, p = 0.004). Females are significantly more likely to have a type I or II glenoid notch, while males are significantly more likely to have a type III notch. This difference could explain the higher incidence of shoulder dislocation in males compared to females.

Keywords*: Glenoid notch; Glenoid fossa; Gleno-humeral joint.*

***** *Correspondence to*: **Dr Abduelmenem Alashkham**. Department Human Anatomy, University of Edinburgh. Old Medical School, Teviot Place, EH8 9AG, Edinburgh, United Kingdom Abduelmenem.alashkham@ed.ac.uk

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INTRODUCTION

The peak incidence of shoulder joint dislocation occurs between 20 and 60 years of age. Anterior dislocation accounts for the majority of shoulder dislocations which predominately occur in males (Milgrom et al, 2014; Cutts et al, 2009; Bankart, 1923; Ufberg et al, 2004; Chechik et al, 2011; Gutierrez et al, 2012). The recurrence rate of anterior glenohumeral dislocation after initial dislocation in young athletes is between 54% and 92% (Wheeler et al, 1989; Bottoni et al, 2002; Te Slaa et al, 2003; Jakobsen et al, 2007).

Several predisposing factors can lead to anterior dislocation of the shoulder joint. Traumatic causes, such as falling on an abducted arm or contraction as an outcome of seizures of a different origin, or non-traumatic causes, such as chin-up exercises, general capsular laxity and increased external rotation at the shoulder have been reported (Bankart, 1923; Chahal et al, 2010; Ballesteros et al, 2013; Felderman et al, 2009). Many factors can aggravate re-dislocation, with one of the most important being an undiagnosed glenoid bone lesion (Auffarth et al, 2013), or tears in the fibrous capsule and glenoid labrum (Bankart, 1923).

Successful total shoulder replacement needs a well matched fit between the glenoid component and the underlying bone. Loosening of the glenoid is one of the complications, and is considered to be the most common indication for shoulder surgery revision (Fenlin et al, 1994; Franklin et al, 1988; Hawkins et al, 1999).

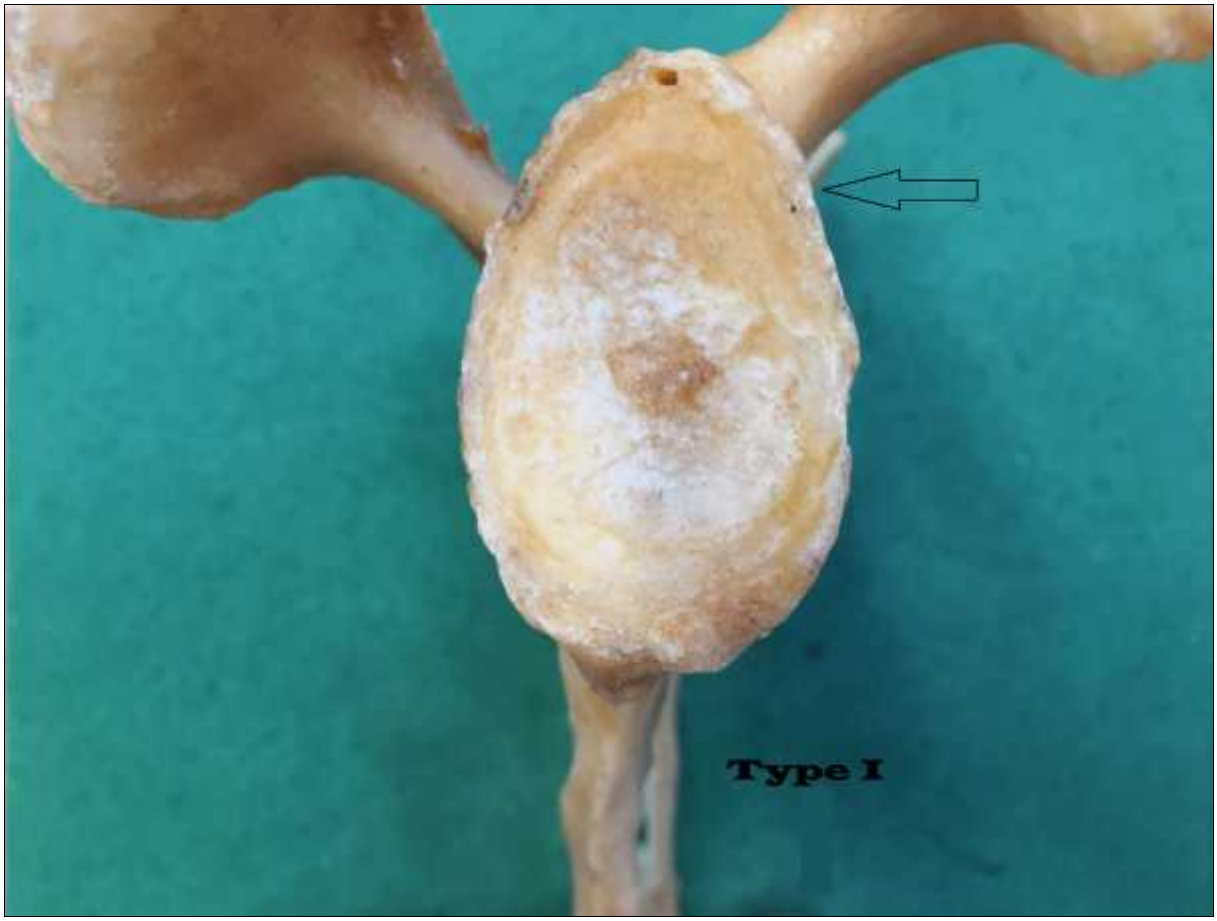

Figure 1- Type I (mild) glenoid notch

Few studies have conducted to report the glenoid notch, however there are a limited number of studies that have attempted to differentiate male from female glenoid notch. Prescher and Klumpen (1997) described the glenoid notch as an indentation in the anterosuperior aspect of the glenoid fossa which was observed in 55% of their sample. Merrill et al (2009) reported the presence of the glenoid notch in 80.4% of female and 57.6% of male scapulae. Therefore, the aims of

this study were to: (i) investigate the incidence and type of glenoid notch, and (ii) its association with gender, age and side.

MATERIAL AND METHODS

All the cadavers were approved by Human tissue (Scotland) Act 2006. A total of 140 shoulders from 30 males and 40 females were dissected and examined. All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous capsule, were inspected and subsequently removed to completely expose of the glenoid fossa. The criteria used for the classification of the glenoid notch was based on notch severity as mild (type I), moderate (type II) or severe (type III) (Figures 1, 2, 3). Type I was defined as an oval shaped glenoid fossa whereas type II and III were defined as pear shaped and comma shaped glenoid fossa respectively.

Figure 2- Type II (moderate) glenoid notch.

The gender, age, side and type of notch present for each specimen were double-entered into the Statistical Package for Social Sciences (SPSS, version 21). Chi square, Kruskal-Wallis, MANOVA and ANOVA tests were subsequently conducted: statistical significance was set at $p < 0.05$. The repeatability and reliability of the type of glenoid notch present was determined by randomly selecting specimens from the study cohort and reassessing notch type by the researcher and by two other individuals on two separate occasions.

RESULTS

The mean (and associated standard deviation) age of the specimens was 81.5 years (±9.8). Using the classification outlined above a type III

glenoid notch was observed in 38% of specimens (53 shoulders), type I in 34% specimens (48 shoulders) and type II in 28% specimens (39 shoulders) (Table I). Type I was observed to be more common in females (34 shoulders) and equally distributed on the right and left sides, while in males it was only observed in 14 shoulders and was more common on the right side. Type II was also more common in females (39 shoulders), but was more common on the left side: in males it was observed in 14 shoulders and was equally distributed on the right and left sides. In contrast type III was more commonly observed in males (32 shoulders) compared to females (21 shoulders): in males it was more common on the right side, while in females it was more common on left side.

Figure 3- Type III (severe) glenoid notch.

Multivariate analysis showed that glenoid notch type was significantly associated with sex (χ^2 [2, n=140] = 11.088, p = 0.004). Kruskal-Wallis tests revealed a significant difference between males and females in glenoid notch types I and type III (χ^2 [1, n=101] = 9.79, p<0.002), with a mean rank of 59.27 for type I and 43.51 for type III. There also was a significant difference between males and females in glenoid notch types II and type III (χ^2 [1, n=92] = 5.32, p<0.021), with a mean rank of 52.99 for type II and 41.72 for type III. The difference between types I and II was not significant between males and females. Similarly, the association between glenoid notch type and side was not significant.

DISCUSSION

The underlying causes of a glenoid notch have not been fully explored, but a number of assumptions have been suggested. Prescher and Klumpen (1997) assumed it was due to pressure from the tendon of subscapularis as it passed anterior to the glenoid fossa causing atrophic

changes in the bone, therefore leading to the formation of a notch. According to Merrill et al (2009) the glenoid notch has been observed in only 80.4% of female and 57.6% of male scapulae. The authors believe that a glenoid notch is present in all scapulae, but with different degrees of severity; therefore, a new classification is suggested as used in the current study: type I (mild), type II (moderate) and type III (severe). In the current study type III was most commonly observed (n=53 shoulders: 38% of specimens), then type I (n=48 shoulders: 34% of specimens) and finally type II (n=39 shoulders; 28% of specimens).

Crosstab					
			Gender		Total
			Male	Female	
Types	I	Number	14	34	48
		% within Type	30%	70%	100.0%
		% within Sex	23%	43%	34%
		% of Total	10%	24%	34%
	II	Number	14	25	39
		% within Type	36%	64%	100.0%
		% within Sex	23%	31%	28%
		% of Total	10%	18%	28%
	III	Number	32	21	53
		% within Type	60%	40%	100.0%
		% within Sex	53%	26%	38%
		% of Total	23%	15%	38%
Total		Number	60	80	140
		% within Type	43%	57%	100.0%
		% within Sex	100.0%	100.0%	100.0%
		% of Total	43%	57%	100.0%

Table 1- Gender and glenoid notch types Cross-Tabulation of the study group

An association between the type of glenoid notch and gender has not been previously reported; however, in the current study multivariate analysis showed that the type of glenoid notch is significantly associated with gender ($p<0.001$).

Due the presence of the rotator cuff muscles both Palastanga et al (2006) and Sinnatamby (2006) assume that anterior dislocation of the shoulder is not common. However, Cutts et al (2009), Bankart (1923), Ufberg et al (2004), Chechik et al (2011) and Gutierrez et al (2012) disagree stating that as the shoulder joint is the most mobile joint in the body anterior dislocation accounts for the majority of dislocations and occur predominately in males. The current study found that females were significantly more likely to have a type I or II glenoid notch and males significantly more likely to have a type III glenoid notch. This could explain the higher incidence of shoulder dislocations seen in males compared to females. However, other factors could also be contributing factors, such as the thickness and depth of the glenoid labrum and the degree of glenoid inclination.

It could be questioned if there is any correlation between the glenohumeral dislocation and the existence of the glenoid notch. Prescher and Klumpen (1997) reported that the glenoid labrum in the area of the notch is not attached to the glenoid bony margin of the glenoid cavity but bridges the notch itself instead allowing formation of a small recess; such an attachment of glenoid labrum makes the glenohumeral joint less resistant to dislocating forces, labral tears and

avulsions which commonly takes a place at the anterior margin of the glenoid cavity. Rajendra et al (2016) reported that a deep glenoid notch was seen in 56% of the specimens suggesting that in cases of glenohumeral dislocation, this type should be searched for and repaired for good congruency. The authors also proposed that the oval type of the glenoid cavity was the most stable type of glenohumeral joint as the glenoid labrum is attached along all the margin of glenoid whereas triangular shaped glenoid cavity is more vulnerable for glenohumeral dislocations as the glenoid labrum is not attached to the anterior and posterior glenoid cavity margins. The current study observed that there was no association between the type of notch and side or age. However, this study was cadaveric based study and had its limitation to correlate the relationship between the type of glenoid notch and glenohumeral dislocation; therefore, it is suggested that further research is required to clarify the relationship between notch type and glenohumeral dislocation.

A new classification system of assessing a glenoid notch is presented which was used to investigate the association between the type of glenoid notch and sex. The observations confirm that glenoid notch type is significantly associated with sex ($p = 0.004$), females being significantly more likely to have types I and II and males significantly more likely to have type III. This study was cadaveric based study and was unable to investigate the correlation between gleno-humeral joint dislocation and type of glenoid notch; therefore, further research is required to clarify whether there is a relationship between the type of glenoid notch and shoulder dislocation.

Conflict of interest

None of the authors has any conflict of interest.

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University of Zawia, Zawia, Libya.

Ethical Approval, Informed Consent

All the cadavers were approved by 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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