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MAGNETIC RESONANCE IMAGING BASED MORPHOMETRIC ASSESSMENT OF GLENOID

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This study aimed to evaluate the morphological variations of the glenoid in an Asian population and compare them with those in the Western population. A retrospective study of 100 patients who presented with shoulder pain between Jan. 2018 and Jan. 2019 was done. The glenoid height, width and version were measured on coronal and axial images. The overall mean version was found to be an anteversion of 0.40 ± 3.6. The average glenoid widths in males and females were 29 mm and 25.2 mm respectively, whereas the overall average glenoid width was 27 ± 3.2 mm. The average glenoid heights in males and females were 35.7 mm and 32.4 mm respectively, whereas the overall average glenoid height was 34 ± 2.5 mm. The glenoid dimensions in the Asian population were found to be slightly less than the ones in the Western population. This difference has to be considered when choosing a prosthesis for shoulder arthroplasty.

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Key words: *glenoid, magnetic resonance imaging, arthroplasty, central India*

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Introduction

Reverse Total Shoulder Arthroplasty (RTSA) was reserved for patients with a failed total shoulder replacement or a massive or irreparable cuff tear. With the initial success of the RTSA and the bony increased offset-reverse shoulder arthroplasty (BIO-RSA), the indications of the RTSA have been extended.

A wide variety of RTSA prostheses is available in the market, most of which are designed based on data from the Western population. Even a subtle change in the dimensions of prosthesis can lead to its improper placement. For the same reason, implanting the glenoid component of RTSA prosthesis is a challenge. Therefore, glenoid dimensions such as glenoid length and width play a crucial role in choosing an ideal prosthesis. As mentioned above, due to the wide variations in the demographic anatomy of the shoulder joint, a prosthesis designed based on western demographic data may not be suitable for use in different populations. This discrepancy has been identified by several groups and has led to studies to identify the demographic differences in glenoid morphology. Magnetic resonance imaging (MRI) has the added advantage of evaluation of the glenoid cartilage as well. The glenoid diameter changes significantly with the thickness of the glenoid cartilage thereby affecting the prosthesis design.

A number of studies have been done to identify glenoid morphology in various populations based on cadaveric specimens as well as 3-dimentional Computed Tomography (3D CT) of living subjects. This study aims to evaluate the glenoid width, height and version of a small Indian population on MRI and to compare these with that of the Western population.

Materials and Methodology

A retrospective study of 100 patients, who presented with shoulder pain between Jan. 2018 and Jan. 2019, was done in a single institution in India. Patients between the ages of 20 and 80 years were included in the study. Patients with a history of surgery or significant trauma were excluded from the study. IEC approval and consent from patients were obtained from all cases.

Multiplanar T2 weighted and proton density (PD) weighted fat-suppressed images were obtained in a GE 1.5 Tesla Seimens MRI machine. Proton density weighted images were obtained with TR 2400 ms and TE 30 ms. T2 weighted images were obtained with TR 3500 ms and TE 60 ms. Axial and oblique coronal sections of 3 mm thickness were obtained with an FOV of 140 mm. Oblique coronal images were obtained parallel to the Supraspinatus tendon. Images were taken with the patient in the supine position, arm adducted and forearm in the supine position. All the scans were done by the same technician using a standard protocol which included the above-mentioned sequences as well.

Glenoid dimensions such as height, width and version were measured on coronal and axial images. The angle between a line drawn along the glenoid surface and a mid-glenoid line was measured on an axial PD FatSat section with maximum glenoid width to determine the glenoid version (Figure 1)(1). The mid-glenoid line, A was drawn from the medial edge of the scapula to the mid-point of the glenoid. A second line, B was drawn along the surface of the glenoid. The angle between line A and line B was taken as the angle of the version. The angle of the version was calculated by subtracting the measured angle from 90 degrees. A negative angle was considered retroversion and a positive angle was considered anteversion. The glenoid width was measured on axial T2/PD FatSat as the maximum anteroposterior distance (Figure 2). The glenoid height was measured on coronal T2/PD FatSat as the maximum superior-inferior distance (Figure 3).

Statistical analysis was done using SPSS (Version 17.0) software. Both t-test and ANOVA tests were used for data analysis.

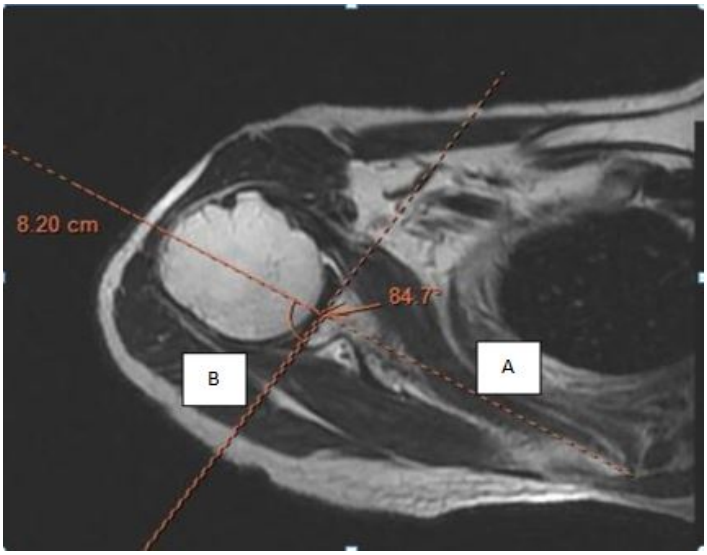

Figure 1. Measurement of glenoid version on an axial T2 weighted image

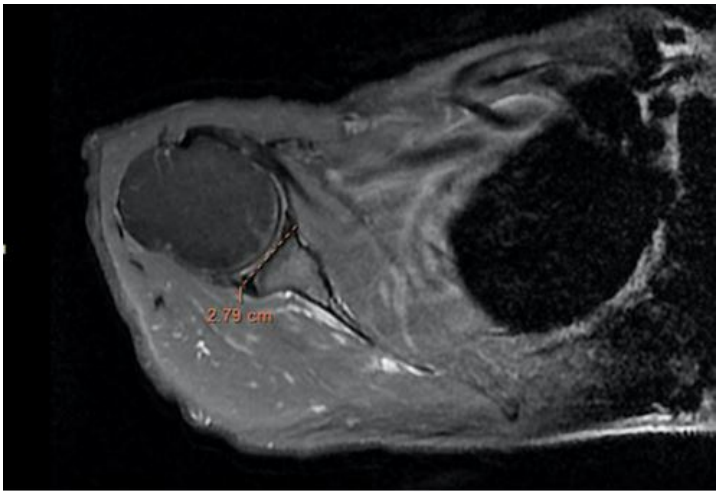

Figure 2. Measurement of glenoid width on an axial PD image

Figure 3. Measurement of glenoid height on a coronal PD image

Results

A total of 100 patients were selected for the study, out of which 49 were males and 51 were females. The mean age in this study was found to be 43.2 ± 13.8 years. The mean glenoid retroversion was found to be 3.45 ± 2.23 and anteversion was found to be 2.66 ± 1.95. The overall mean version was found to be an anteversion of 0.40 ± 3.6. The average glenoid widths in males and females were 29 mm and 25.2 mm respectively, whereas the overall average glenoid width was 27.0 ± 3.2 mm. The average glenoid heights in males and females were 35.7 mm and 32.4 mm respectively, whereas the overall average glenoid height was 34.0 ± 2.5 mm (Table 1 and Table 2).

Table 1. Comparison of glenoid width and height in males and females

	MALE (mm)	FEMALE (mm)
GLENOID WIDTH	29	25.2
GLENOID HEIGHT	35.7	32.4

Table 2. Average glenoid dimensions in the study population

	MEAN (mm)	STANDARD DEVIATION (mm)
GLENOID VERSION • RETROVERSION • ANTEVERSION	 3.45 2.66	 2.23 1.95
GLENOID WIDTH	27.0	3.2
GLENOID HEIGHT	34.0	2.5

Discussion

Most of the studies on the glenoid normal morphometry of the Indian population are based on CT of living subjects or cadaveric specimens. Relatively fewer studies have been done based on MRI, which is the modality of choice to evaluate patients with shoulder joint pathologies. Unlike other studies, the strength of our study is the consideration of the regional articular cartilage thickness which can further affect the congruity of the implants and can make small but important changes in the morphometric dimension of the glenoid base plate and design.

Reverse total shoulder replacement has been gaining popularity all over the world since its approval by the US FDA in 2003 for the management of arthritis associated with rotator cuff diseases (2). It is now being widely used for other conditions such as inflammatory arthropathy with an associated rotator cuff tear, proximal humeral fractures, post-traumatic arthritis, and fixed glenohumeral dislocation as well as revision arthroplasty (3) . The long-term success of RTSA makes it a preferred procedure over total shoulder replacement. But compared to total shoulder arthroplasty, the incidence of peri-operative complications is higher in RTSA, comprising about 15% (4). The most common of these complications are instability, loosening of prosthesis, scapular notching and infections. Out of these, instability of the joint and mechanical failure have been partly attributed to a faulty implant. An improper size or placement of the glenoid baseplate can result in the same. Only a limited number of glenoid baseplate sizes are available for RTSA and there is a great demographic variation in glenoid morphology, hence, the higher incidence of peri-operative complications. The smallest available baseplate for RTSA measures about 25 mm (5).

Glenoid variations between sexes should be considered when choosing an appropriate prosthesis. However, there have been very few studies that have taken this into account. A study done by Sandra et al. in Switzerland has shown significant differences in glenoid height and width of males and females. The average glenoid height in males was found to be 39.5 ± 3.5 mm whereas in females it was 34.8 ± 2.2 mm. The average glenoid width in males was 30.3 ± 3.3 mm and in females was 26.2 ± 1.6 mm (6).

A 3D C-based study done by Meshram et al. on an Indian population, found the mean glenoid height to be 33.9 ± 3.1 mm, glenoid width to be 24.2 ± 2.1 mm and glenoid retroversion to be 3.4 ± 4.7 (7). These values were found to be slightly less than the values in our study, which could probably be due to the higher sensitivity of CT for the evaluation of bone. A study done by Singh et al. on 100 dry scapula specimens of a similar population found the mean glenoid height to be 34.24 ± 3.27 mm and the mean glenoid width to be 23.93 ± 2.67 mm (8).

A dry specimen study done by El-din et al. in an Egyptian population found the mean glenoid height to be 38.95 ± 2.73 mm and the mean glenoid width to be 28.15 ± 2.69 mm. This study found a racial difference in glenoid morphology and pointed to a possibility of the same affecting the stability of the glenohumeral joint (9). A study done by Churchill et al. on 344 dry scapular specimens in the USA found the mean glenoid height, width and version to be 35.1 mm, 25.7 mm and 1.2 degrees, respectively (10).

In our study, the mean glenoid retroversion and anteversion were found to be 3.45 ± 2.23 and 2.66 ± 1.95, which were comparable to previous studies done on a similar population (7). There was no correlation between sex and age with the glenoid version.

The main drawback of this study was the presence of intra- and inter-observer variations. However, this was issue was addressed to a great extent by obtaining an average of three readings. Another limitation of this study was the relatively small sample size, which may not accurately represent the diverse Indian population.

Conclusion

The glenoid dimensions of our population are comparable with other Indian populations considered in this study. However the same is found to be slightly higher in the Western population. These differences in glenoid dimensions have to be considered in planning Reverse Total Shoulder Arthroplasty (RTSA) as they can significantly alter the outcome of the procedure. There is a clinical necessity to develop appropriate glenoid base plates for a better prosthesis fit in the Indian population.

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MORFOMETRIJSKA PROCENA GLENOIDA UPOTREBOM MAGNENTNOREZONANTNOG IMIDŽINGA

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Rad je imao za cilj da proceni morfometrijske varijacije glenoida u azijskoj populaciji i uporedi ih sa onima u zapadnoj populaciji. Retrospektivna studija obuhvatila je 100 bolesnika lečenih zbog bolova u ramenu u periodu od januara 2018. do januara 2019. godine. Dimenzije glenoida, visina, širina i verzija bile su merene na koronalnim i aksijalnim snimcima. Utvrđeno je da je ukupna srednja verzija bila anteverzija od 0,40 ± 3,6. Prosečna širina glenoida kod muškaraca iznosila je 29 mm, a kod žena 25,2 mm, dok je ukupna prosečna širina bila 27 mm ± 3,2 mm. Prosečna visina glenoida kod muškaraca bila je 35,7 mm, a kod žena 32,4 mm; ukupna prosečna visina bila je 34 mm ± 2,5 mm. Došlo se do zaključka da su dimenzije glenoida u azijskoj populaciji nešto manje od onih u zapadnoj populaciji. Ovu razliku treba uzeti u obzir prilikom izbora proteze za artroplastiku ramena.

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***Ključne reči**: glenoid, magnetnorezonantni imidžing, artroplastika, centralna Indija*