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Original Research Article

HUMERAL HEAD AND GLENOID DIMENSIONS IN THE INDIAN POPULATION: A CADAVERIC STUDY

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ABSTRACT

Background: Shoulder prosthesis should accurately mimic the proximal shoulder and glenoid anatomy to recreate the shoulder biomechanics. There may be a mismatch in the sizes of the Indian native bone and the currently available western shoulder prosthesis, since the bony morphology of Indians may be different from that of the western counterpart.

Purpose: To measure the average humeral head diameter and glenoid length and width, so that a proper implant selection may be done based on the knowledge of average Indian bony morphology.

Methods: Twenty shoulders in ten fresh cadavers were dissected to expose the humeral head and glenoid articular surface. The humeral head diameter was measured with the help of a digital vernier caliper in two planes: Supero-inferior diameter (D1) and antero-posterior diameter (D2). The glenoid length (l) and width (w) were measured with the help of a vernier caliper.

Results: The average humeral head diameter (D1) ± S.D. in the Supero-inferior plane was 45±3.4 mm (range 40-50.6mm) and antero-posterior (D2) plane was 42.7±2.2 mm (range 40-46mm) with a mean difference of 2.2 mm. The average length of the glenoid (l) was 35.4±1.3 mm (range 32-37mm) and width of the glenoid (w) was 25.3±2.1 mm (range 21-28mm). The shape of the humeral head was more ellipsoidal at diameters above 45 mm.

Conclusion. We can conclude that the humeral head diameters and glenoid length and width in Indian population are smaller than the western counterparts. The ellipsoidal shape of the humeral heads becomes more marked at diameters above 45mm.

KEY WORDS: Cadaver Study, Humeral Head Diameter, Glenoid Length, Ellipsoid Humeral Head, Shoulder Prosthesis.

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INTRODUCTION

Proximal humerus fractures, rotator cuff arthritis and gleno-humeral osteo-arthritis are a common problem in the Indian population. Rotator cuff arthritis and gleno-humeral osteoarthritis are frequently treated by reverse shoulder replacement or anatomical shoulder replacement. In order to recreate the normal biomechanics and kinematics of the shoulder joint in an anatomical replacement, it is important to restore the normal anatomy of the proximal humerus [1]. The native humeral head is replaced with prosthesis of similar diameter and depth [2]in all anatomic replacement procedures like hemi-replacement or total anatomic shoulder replacement. However, there

exists certain differences in the Indian and western bony dimensions and morphology [3]. But the available implants for shoulder replacement have been designed according to the western bony morphology. Due to this mismatch, it is possible that the existing available implants may be inadequately sized for our Indian population. In case of a badly comminuted humeral head or proximal humerus fracture, the correct humeral head diameter may not be ascertained, and prosthesis may have to be selected by basing it on the knowledge of average Indian humeral head size. Similarly the average size of glenoid should be known to select the appropriate sized glenoid base plate in the reverse shoulder system. There is limited literature on the shoulder bony morphological parameters in the Indian population. The purpose of this study was to measure the average humeral head diameter and glenoid length and width, so that a proper implant selection may be done based on the knowledge of the bony geometry.

MATERIALS AND METHODS

Twenty shoulders in ten fresh male cadavers of Indian origin (Maharashtra region) were dissected to expose the humeral head and glenoid articular surface. The humeral head diameter was measured with the help of a vernier caliper in two planes: Supero-inferior diameter (D1) in coronal plane and antero-posterior diameter (D2) in axial plane (figure 1). The glenoid length (l) and width (w) were measured with the help of a vernier caliper (figure 2). The data was represented as an average ± (Standard deviation). Correlation co-efficient between the average humeral head diameters D2 and D1 was calculated.

RESULTS

The humeral head height was measured in ten cadavers and glenoid length and width could be measured in only nine cadavers as glenoid was fractured in one of the cadavers (Table 1). The average humeral head diameter (D1) ± S.D. in the Supero-inferior plane was 45±3.4 mm (range 40-50.6mm) and antero-posterior (D2) plane was 42.7±2.2 mm (range 40-46mm). The average length of the glenoid (l) was 35.4±1.3 mm (range 32-37mm) and width of the glenoid (w) was 25.3±2.1 mm (range 21-28mm).

Pearson's correlation of coefficient showed a strong correlation between D1 and D2 (0.88). The correlation between humeral antero-posterior diameter (D2) and supero-inferior diameter (D1) was D2= 0.5763*D1+16.79. It was found that the supero-inferior diameter of humerus was larger than the antero-posterior diameter by a mean of 2.2 mm and with increasing values of supero-inferior diameter above 45mm, this difference increased to a mean of 3.6 mm.

Fig. 1: Humeral head diameter measurements:

Fig. 1a: Supero-inferior diameter(**D1**)

Fig. 1b: Antero-posterior diameter(**D2**)

Fig. 2: Glenoid cavity length measurements

Fig. 2a: Length (**l**)

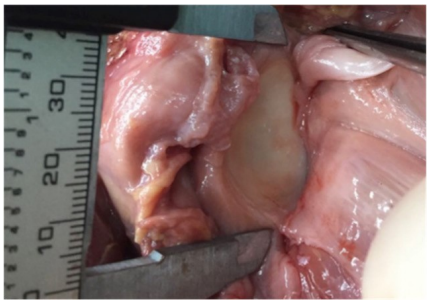

Fig. 2b: Width (**w**)

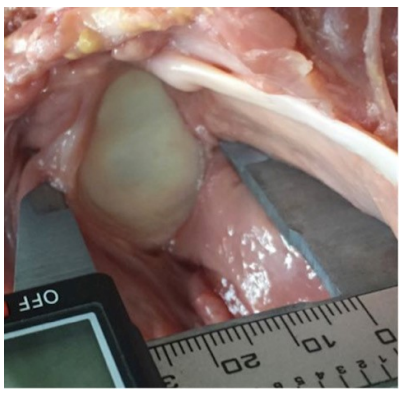

Table 1: humeral head diameters (in mm) and glenoid length and width (in mm).

	Diameter of the humeral head				Glenoid cavity			
	Superoinferior(D1)		Anteroposterior(D2)		Superoinferior(l)		Anteroposterior(w)	
	Right	Left	Right	Left	Right	Left	Right	Left
1	40	40	40	40	35	32	21	21
2	44.8	44.4	44	44.3	35.8	36.3	24.2	24.4
3	49	50.6	45.6	46	35.5	35.5	23.5	23.5
4	48	49.5	45	44.6	34	34.5	25	25.6
5	45	43	44.8	42.7	36.2	34	25.6	24.7
6	45.8	45.3	43.2	42.3	35	37	27	27
7	48	48	43	44	37	37	28	27
8	42	41	40	40	35	35	28	28
9	48	45	43	43	36	36	26	25
10	41	40	39	39				

DISCUSSION

This study was done to measure the humeral head diameters and the glenoid length and width in cadaveric shoulders. We found that the average supero-inferior and antero-posterior humeral head diameter was 45 mm and 42.7mm, respectively with a mean difference of 2.2 mm. This difference increased to a mean of 3.6 mm with an increase in supero-inferior diameter above 45mm. This means that the head became more elliptical in shape as the supero-inferior diameter increased to more than 45mm. The glenoid length was a mean of 35.4 mm and the width was a mean of 25.3mm.

The ellipsoidal shape of the humeral head is well described by many authors [2, 4-6]. The ellipsoidal shape of the humeral head at larger diameter should be borne in mind by the operating surgeon. This is significant because many implant systems available in the country have spherical humeral head implants. Furthermore these implants have been manufactured according to western bony morphology and may be inadequate for our Indian population. Certain implant systems like that of the second Generation Zimmer shoulder implant have limited availability of the humeral head sizes that may not be adequate for our Indian population especially if the native head diameter exceeds 46 mm as is seen in 3 of our cadaveric specimens. The choice of the implant system should have all the head sizes available as per the Indian bony morphological parameters (40-50mm as per our study).

Our finding that at higher diameters, the humeral head becomes more ellipsoidal has been found to be true by Humphrey et al[7]. According to Humphrey et al, the supero-inferior diameter increases more than antero posterior diameter at increasing values of supero-inferior diameter. This difference is < 4 mm at diameters below 50 mm but increase to 9 mm at diameters of more than 50 mm. We also found that the head of humerus is close to a sphere at smaller diameters. This has implication in choosing the correct size of humeral head implant in Shoulder arthroplasty. Since the implants available are likely to be spherical in shape, the smaller diameter, which is the antero-posterior diameter of the native humeral head, if used to decide about the final size of the humeral head implant, can lead to a mismatch in the supero-inferior diameter. Choosing the head size based on the supero-inferior diameter may lead the surgeon to choose a bigger sized humeral head implant since at higher diameters the supero-inferior diameter is found to be bigger than the antero-posterior diameter. Since we could also get a linear correlation between the two diameters, if the coronal diameter is known, the sagittal diameter could be calculated by the formula D2= 0.5763*D1+16.79. This may help in future designing of Indian hemi shoulder prosthesis.

Choosing an implant that is sized larger than a native humeral head may cause persistent shoulder pain, early implant wear, or rotator cuff tear due to a mismatch in the size of the implant[8, 9].

A bigger head diameter may lead to overstuffing and earlier wear out of the Implant and/or the native glenoid leading to bad outcomes after a replacement surgery[2, 10].

The humeral head diameters in non-Asian population are found to be larger than the Asian population[4]. They range from 43-51 mm in diameter[5, 11]. Asian humeral head are generally found to range from 40-46mm[12, 13]. Japanese, Chinese and Thai studies have found their proximal humeral head geometry that is the diameter, neck shaft angle and radius of curvature to be different than the western counterparts[13, 14]. This has implications in shoulder hemi-replacement and reverse shoulder arthroplasty that are used in Indian population. The glenoid length and width in our study was also significantly smaller than the western counterparts (length of 35mm in our study as compared to 39mm in western studies and width of 24mm in our study as compared to 29mm in western studies) as reported by Ianotti et al[6]. This is important in reverse shoulder arthroplasty where the smallest glenoid baseplate size is 26 mm in some implant manufacturers portfolio like Biomet.

The limitations of our paper include low number of cadavers because of the limited availability of fresh cadavers. However, we did not find any other Indian cadaveric shoulder morphometric study in PubMed. This is a preliminary study with indicative results and further studies via CT scan on a larger population may be needed. We also did not measure the neck shaft angle, radius of curvature, retroversion angle in our specimen, since that will also be different than the western counterpart as found in other Asian studies. The other limitation is that we had only male cadavers, so the results cannot be applied on female population.

CONCLUSION

We can conclude that the humeral head diameters and glenoid length and width in Indian population are smaller than the western counterparts. The humeral heads are spherical at lower diameters and become more ellipsoidal with an increase in supero-inferior diameters. Selection of the humeral head implant which is spherical in shape should be done carefully based on availability of all head sizes and based on the antero-posterior and the supero-inferior diameter.

Conflicts of Interests: None

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