



A STUDY OF MORPHOMETRIC ANALYSIS AND MEASUREMENT OF ANGLE OF TORSION OF THE HEAD OF HUMERUS AND SHOULDER ARTHROPLASTY

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ABSTRACT

Back ground: Humerus is the longest of the long bones of superior extremity. Its head articulates with scapular glenoid cavity to form the gleno-humeral/Shoulder joint. The rounded head of Humerus is too weakly supported in the scapular glenoid cavity lined by glenoid labrum which makes it the most mobile and most unstable joint and so most commonly dislocated joint of the human body. Also the humeral head part is the 2nd most important part of shoulder arthroplasty. Aim of the study is to make a clinical evaluation of parameters used in prosthesis design for the humeral component applied in arthroplasty of the proximal upper extremity.

Methods: A total of 100 (Rt -58, Lt -42) dry human Humerus available in the Department of Anatomy of Calcutta National Medical College, Kolkata, West Bengal and Nilratan Sircar Medical College, Kolkata, West Bengal were taken for the study. The Humeral heads are measured in supero-inferior (SI) diameter, and antero-posterior diameter (AP), The width of Humeral head (Wdth), and angle of Humeral Torsion were measured. At the very beginning the both sided Humerus taken for the study are properly numbered using permanent marker pen. The width of the Humeral head (Wdth) is measured 1stly by pressing the head in modelling dough and when the mould is prepared, semisolid plaster of paris is filled into the mould. After drying the replica of humeral head is smoothened upto the mark of anatomical neck of humerus thus proper width can be measured. The supero-inferior (SI) diameter, and antero-posterior diameter (AP) were measured by digital slide callipers by placing it directly onto the surface of consequently numbered humeral heads. The width of Humeral head (Wdth) were measured from these replica (properly numbered) humeral heads, made of plaster of paris at the middle, the highest thickness was measured. The measurements are taken via spreading slide calipers in millimeters.

For measuring the angle of humeral angle of torsion, we fixedly placed the humerus on to a area over the smooth part of the vertical wall which was meeting another horizontal wall at 90 degrees angle thus the line joining the two epicondyles of humerus lies parallel to the vertical wall. Now placing the straight edge of the protractor onto the upper end of humerus the angle of humeral torsion is measured.

Results: Both sided Humerus were analysed separately for Morphological measurement, and angle of Humeral torsion. Mean values for SI were 41.31 ± 3.46 mm (Right side) and 40.91 ± 3.27 mm (Left side). Mean values for AP were 38.27 ± 3.05 mm (Right side) and 37.91 ± 2.70 mm (Left side).

Conclusion: This study will contribute some relevant data and help the orthopaeditions in dealing with cases of shoulder pathology and shoulder arthroplasty cases.

KEYWORDS : Humeral Head Morphology, angle Of Humeral Torsion, shoulder Arthroplasty.

INTRODUCTION:

The Humerus is the longest of the long bones of upper extremity and the only bone of upper arm. The glenoid cavity of the scapula, lying on its superolateral aspect articulates with the head of the humerus to form the Shoulder joint. The Vertical/Supero-inferior diameter (SI) of the Humeral head is the longest. The shoulder joint is the most frequently dislocated joint in the body. Dislocations with fractures of the upper end of Humerus are also quite common in trauma. Shoulder dislocation and to decide the proper size of the Humeral component in the shoulder arthroplasty is the aim of the present study. So we made our goal to obtain anthropometric data of the head of Humerus specifically the diameters of the head, its width, angle of torsion to Indian population which will help in better understanding and management of Shoulder pathologies. The dimensions of head of Humerus are important for evaluating percentage bone loss in presence of Hillsach's lesion and for Shoulder replacements. Moreover it has been observed, only the lower sizes of the available prosthesis fit in for the Asian population and sometimes leads to overstuffing, discomfort and restricted movements of joint. Restoration of normal anatomy is important to maintain optimal lever arm of Deltoid and cuff muscle. The Gleno-humeral joint is a multiaxial ball and

socket synovial joint, however humeral head curve do not match the Glenoid curve. The head of the humerus is larger than the glenoid fossa, so only part of the humeral head articulates with the glenoid fossa in any position of the joint. Any drift from normal anatomy will cause abnormal kinematics and early failure of Surgery [1, 2, 3, 4].

MATERIALS AND METHODS :

A total 100 (Rt-58, Lt-42) adult dry Humerus collected from the Dept. of Anatomy, Calcutta National Medical College, Kolkata, West Bengal for the study. The age and sex of the bones were not known. Out of these 42 Humerus were of left sided and 58 were of right sided. Those Humerus which were found to be damaged at the upper end were excluded from the study.

Morphometric Analysis Of Head Of Humerus

At the very beginning the both sided Humerus taken for the study are properly numbered using permanent marker pen. The edge of the Humeral head is highlighted with coloured chalk and the The supero-inferior (SI) diameter, and antero-posterior diameter (AP) were measured by digital slide callipers by placing it directly onto the surface of consequently numbered humeral heads. The width of the Humeral

head(Wdth) is measured 1stly by pressing the head in modelling dough,when the mould is prepared,semisolid plaster of paris is filled into the mould.

After drying the replica of humeral head is smoothened upto the mark of anatomical neck of humerus thus proper width can be measured. The width of Humeral head (Width) were measured from these replica(properly numbered) humeral heads, made of plaster of paris at the middle, the highest thickness was measured. We have taken 4 additional measurements of the thickness of humeral head at 4 different points taken from the marzins at the level of anatomical neck where the supero-inferior(SI) and antero-posterior(AP) diameters were measured.

The measurements are taken via spreading slide calipers in millimeters.

For measuring the angle of humeral angle of torsion ,we fixedly placed the humerus on to a area over the smooth part of the vertical wall which was meeting another horizontal wall at 90 degrees angle thus the line joining the two epicondyles of humerus lies parallel to the vertical wall.Now placing the straight edge of the protractor onto the upper end of humerus the angle of humeral torsion is measured.

The Supero-Inferior diameter (SI):

The SI diameter is measured from superior to inferior bony points over the margin of head of Humerus at the level of anatomical neck.

Anteroposterior diameters(AP):

The AP diameter is measured by taking maximum antero-posterior diameter joining the bony points over the margin of head of Humerus at the level of anatomical neck.

Width of Humeral head(Wdth)

The width of the Humeral head(Wdth) is measured 1stly by pressing the head in modelling dough,when the mould is prepared, semisolid plaster of paris is filled into the mould.

After drying the replica of humeral head is smoothened upto the mark of anatomical neck of humerus thus proper height can be measured. The width of Humeral head (Wdth) were measured from these replica(properly numbered) humeral heads, made of plaster of paris at the middle, the highest thickness was measured.

We have taken 4 additional measurements of the thickness of humeral head at 4 different points taken from the marzins at the level of anatomical neck where the supero-inferior(SI) and antero-posterior(AP) diameters were measured.

The measurements are taken via spreading slide calipers in millimeters.

Angle of Humeral torsion(HT) :-

For measuring the angle of humeral angle of torsion ,we fixedly placed the humerus on to a area over the smooth part of the vertical wall which was meeting another horizontal wall at 90 degrees angle thus the line joining the two epicondyles of humerus lies parallel to the vertical wall.Now placing the straight edge of the protractor onto the upper end of humerus the angle of humeral torsion is measured.

STATISTICAL METHOD:-

All the datas were entered into microsoft excel spreadsheet and analysed by SPSS version 20.0.1.

Fig 1. Technique Of Measurement Of Antero Posterior Diameter Humeral Head For Morphometric Analysis.



Fig 2.technique Of Measurement Of Humeral Head Height For Morphometric Analysis.

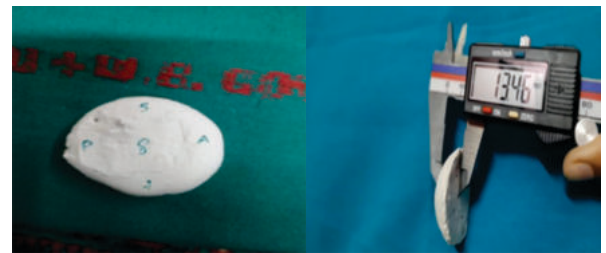


Fig 3.technique Of Making Mould (a & B),picture Of Mould Of Humeral Head (c) And Measurement Of Humeral Head Width At The Center (d) For Morphometric Analysis



(a)

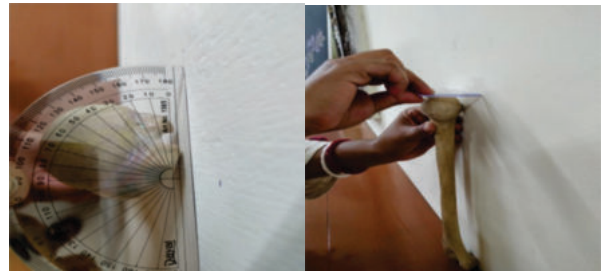
(b)



(c)

(d)

Fig 4.technique Of Measurement Of Humeral Head Torsion For Morphometric Analysis.



RESULTS :-

Datas analysed following statistical method and final results are represented in tabular forms.

Table 1. Percentage of the Humeral head of Right and Left side

| HUMERUS | TOTAL | RIGHT SIDED | LEFTSIDED |
|------------|-------|-------------|-----------|
| NUMBER | 100 | 58 | 42 |
| PERCENTAGE | 100 | 58 | 42 |

Table 2:- Distribution of cases according to different dimensions of Humeral head

| | RT (n=58) | | | LT(n=42) | | |
|----------------------|-----------|-------|--------------|----------|-------|--------------|
| | MAX | MIN | MEAN+SD | MAX | MIN | MEAN+SD |
| SI (mm) | 49.93 | 34.85 | 41.31 ± 3.46 | 46.3 | 34.22 | 40.91 ± 3.27 |
| AP(mm) | 44.69 | 32.63 | 38.27 ± 3.05 | 43.30 | 32.64 | 37.91 ± 2.70 |
| Width at centre (mm) | 17.8 | 13.36 | 15.75 ± 1.08 | 17.89 | 13.6 | 15.97 ± 1.02 |
| Torsion (degrees) | 66 | 34 | 46.41 ± 8.05 | 63 | 36 | 51.45 ± 7.25 |

The maximum SI diameter measured was 49.93mm in a right sided humerus and 46.3 mm in a left sided humerus. Minimum SI diameter was 34.85mm in a right sided scapula and 34.22mm in left sided humerus.

The maximum AP diameter measured was 44.69 mm in a right sided humerus and 43.30 mm in a left sided humerus. Minimum AP diameter was 32.63 mm in a right sided humerus and 32.64 mm in left sided humerus.

The maximum width at the center measured was 17.8 mm in a right sided humerus and 17.89 mm in a left sided humerus. Minimum width at the center was 13.36 mm in a right sided humerus and 13.6 mm in left sided humerus.

The maximum degree of torsion of humeral head measured was 66 degrees in a right sided humerus and 63 degrees in a left sided humerus. The Minimum 34 degrees of torsion of humeral head was measured in a right sided humerus and 36 degrees in left sided humerus.

Table 3:-Morphometric values of total head of Humerus irrespective of side

| | Mean (mm) ± SD | Minimum (mm) | Maximum (mm) |
|----|----------------|--------------|--------------|
| SI | 41.31 ± 3.46 | 34.22 | 49.93 |

Table 5:-Morphometric values of head of Humerus in different references as cited in our study in comparison to our study.

| Name of studies | Number of samples (n) | | | Parameters | Range in mm | | | Mean + SD in mm | | |
|-----------------|-----------------------|-----------|-------|--|----------------|----------------|----------------|-----------------|------------------|----------------|
| | Right side | Left side | Total | | Rt side | Lt side | Total | Rt side | Lt side | Total |
| Refer 1 | 34 | 33 | 67 | Supero-inferior diameter (SI) | 13.00 to 24.00 | 14.00 to 26.00 | 13.00 to 26.00 | 18.04 ± .39 | 19.13 ± .1 | 18.58 ± .82 |
| | 34 | 33 | 67 | Antero-posterior diameter(AP) | 33.20 to 45.70 | 33.50 to 46.00 | 33.20 to 46.00 | 39.55 ± .20 | 39.75 ± .76 | 39.65 ± .97 |
| | 34 | 33 | 67 | Angle of Humeral torsion | 20 to 50 | 23 to 55 | 20 to 55 | 37.76 ± .70 | 36.82 ± .08 | 37.30 ± .85 |
| Refer 3 | 49 | 51 | 100 | HB: The distance between the most proximal point of the head of the humerus and surgical neck of the humerus | | | | 37.1 ± 4.8 | 37.7 ± 4.4 | ----- |
| Refer 4 | 52 | 38 | 90 | The mean distances between caput humerus and callum anatomicum | | | | 39.9 ± 6.3 | 39.1 ± 6.1 | ----- |
| Refer 5 | 64 | 56 | 120 | H2: The distance between the most proximal point of the caput humeri and collum anatomicum | | | | 41.0 ± 5.1 | 40.9 ± 3.9 | ----- |
| Refer 6 | 20 | 28 | 48 | Humeral head diameter(HHD) | | | | 42.39 ± .87 | 42.14 ± .2 | 42.24 ± .7 |
| | | | | Angle of inclination(AI) | | | | 131.5° ± 6.91° | -130.21° ± 8.42° | 131.5° ± 6.91° |
| Present study | 58 | 42 | 100 | Parameters | Range in mm | | | Mean + SD in mm | | |
| | | | | | Rt side | Lt side | Total | Rt side | Lt side | Total |
| Present study | 58 | 42 | 100 | SI | 34.85-49.93 | 34.22-46.3 | 34.22-49.93 | 41.31 ± .5 | 40.09 ± .3 | 41.31 ± .5 |
| Present study | 58 | 42 | 100 | AP | 32.63-44.63 | 32.64-43.30 | 32.63-44.69 | 38.27 ± .1 | 37.91 ± .7 | 38.27 ± .5 |

| | | | |
|-----------------|--------------|-------|-------|
| AP | 38.27 ± 3.05 | 32.63 | 44.69 |
| Width at centre | 15.83 ± 1.06 | 13.36 | 17.89 |
| Torsion | 48.35 ± 8.09 | 34 | 66 |

The maximum SI diameter measured was 49.93mm in a right sided humerus. Minimum SI diameter 34.22mm in left sided humerus.

The maximum AP diameter measured was 44.69 mm in a right sided humerus . Minimum AP diameter was 32.63 mm in a right sided humerus.

The maximum width at the center measured was 17.89 mm in a left sided humerus . Minimum width at the center was 13.36 mm in a right sided humerus .

The maximum recorded torsion of humeral head measured was 66 degrees in a right sided humerus . Minimum recorded torsion of humeral head measured was 34 degrees width at the in a right sided humerus .

Table 4:-Morphometric values of total head of Humerus width at four different reference points on both sided humerus.

| WIDTH OF HEAD | RT (n=58) | | LT(n=42) | | TOTAL(n=100) | |
|-----------------------------|---------------|--------------|---------------|--------------|----------------|--------------|
| | RANG E | MEAN ± SD | RANG E | MEAN ± SD | RANG E | MEAN ± SD |
| AT CENTRE | 13.36 to 17.8 | 15.75 ± 1.08 | 13.6 to 17.89 | 15.97 ± 1.02 | 13.36 to 17.89 | 15.83 ± 1.06 |
| AT POINT S, SUPERIOR WIDTH | 9.8 to 16.6 | 13.35 ± 1.79 | 9.89 to 15.17 | 13.84 ± 1.40 | 9.8 to 16.6 | 13.53 ± 1.65 |
| AT POINT I, INFERIOR WIDTH | 10.59 to 15.8 | 13.59 ± 1.50 | 9.46 to 15.8 | 13.76 ± 1.71 | 9.46 to 15.8 | 13.66 ± 1.57 |
| AT POINT A, ANTERIOR WIDTH | 10.18 to 16.2 | 12.87 ± 1.43 | 11.5 to 15.39 | 12.67 ± 2.57 | 10.18 to 16.2 | 12.79 ± 1.93 |
| AT POINT B, POSTERIOR WIDTH | 11.76 to 17.2 | 14.36 ± 1.38 | 11.46 to 16.3 | 14.23 ± 1.20 | 11.46 to 17.2 | 14.31 ± 1.30 |

DISCUSSION:-

| | | | | | | | | | | |
|---------------|----|----|-----|--------------------|------------|-------------|-------------|-----------|-----------|-----------|
| Present study | 58 | 42 | 100 | WIDTH AT CENTER | 13.36-17.8 | 13.36-17.89 | 13.36-17.89 | 15.75±1.1 | 15.97±1.0 | 41.31±3.5 |
| Present study | 58 | 42 | 100 | TORSION in degrees | 34-66 | 36-63 | 34-66 | 46.41±8.1 | 51.45±7.3 | 48.35±8.1 |

There are several studies done by many authors in different times regarding morphometric measurements of proximal humerus for many reasons, like repair of shoulder injuries, age, race, and sex differentiation, rotator cuff injury, shoulder arthrosis etc. In table 5 we have tried to cite some measurements in some studies we followed as references in comparison to our study. Most of the studies partially covers or correlate to our study subject and consequent results are been compared.

As in present day requirement there are several difficult sorts of injuries orthopaedicians deal with as an effect of peoples' modern lifestyle, so also the emergent need for the shoulder replacement and planning for consequent parts of components of shoulder arthrosis are of utmost importance. We expect our study is to provide essential reference for the upcoming modulation of shoulder prosthesis planning and thus help society greatly.

LIMITATION

If we could cover some more humerus in our study it would be more applicable to the practical use of the study data. We have taken 4 additional measurements on the part of the thickness of humeral head as we have found that the humeral articular surface is not uniformly curved in all the humeri. We could not wisely compare our data of 4 additional measurements of humeral head thickness due to lack of reference research papers.

CONCLUSION:

Our study is consistent with the finding that dimensions of Asian proximal humerus. The sizes of humerus prosthesis are based on the western literature, the sizes do not cover all the required sizes for the Asian population, especially lower sizes. The sizes are not available in current set of prosthesis. This indicates that the smaller dimensions of the proximal humerus in the Asian population may have to be contemplated while designing and fitting prosthesis in shoulder replacement. In addition based on our study the average humeral version recorded is 48.35±8.09 degrees. This data is useful to compile and utilize in prosthesis designing and surgical planning.

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