MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2023.12.325.329

Morphometry of Dry Adult Humeri-A Tertiary Care Centre Study

[1]Neha Saraf, [2]M. Natarajan and [3]Mehera Bhoir

[1,3]Department of Anatomy, H.B.T.M.C. and Dr R.N. Cooper Medical College, Juhu, India

[2]Department of Anatomy, L.T.M.C. and Sion Hospital, Mumbai, India

ABSTRACT

To study the morphometry of dry adult humeri. Out of total collection of humeri from the department, 150 undamaged humeri were selected for study. The humeri were of undetermined gender and age. Each humerus was assigned a serial number. The humeri were numbered from 1-150. The maximum length, vertical and transverse diameter of humerus distance between humeral head, greater tubercle and lesser tubercle and circumference of shaft of humerus at surgical neck, mid shaft and distal end were measured. The maximum length of humerus on right side ranged from 270.00-372.00 mm with a mean of 314.64±20.31 mm.The maximum length of humerus on left side ranged from 258.00 mm to 362.00 mm with a mean of 313.47±16.85 mm.The maximum vertical diameter (supero inferior) of head of humerus on right side ranged from 33.03-51.12 mm with a mean of 42.19±3.98 mm. The maximum vertical diameter (supero inferior) of head of humerus on left side ranged from 33.37-48.32 mm with a mean of 41.88±3.11 mm.The maximum transverse diameter (antero posterior) of head of humerus on right side ranged from 28.54-44.97 mm with a mean of 38.37±3.39 mm. The maximum transverse diameter (antero posterior) of head of humerus on left side ranged from 30.40-44.58 mm with a mean of 38.18±2.95 mm. The distance between humeral head and greater tubercle on right side ranged from 6.00-16.00 mm with the mean of 9.54±1.49 mm.The distance between humeral head and greater tubercle on left side ranged from 8.00-15.00 mm with the mean of 10.14±1.45 mm. The present study provides a comprehensive data about the morphometry of human humeri which will help in designing implants and instrumentations and also provides data regarding quantitative anatomy of humerus. Morphometry of Dry Adult Humeri-A Tertiary Care Centre Study.

OPEN ACCESS

Key Words
Humerus, tubercle, morphometry

Corresponding Author
Neha Saraf,
Department of Anatomy, HBTMC and Dr R.N Cooper Medical College, Juhu, India

Author Designation
[1]Assistant Professor

Received: 25 November 2023
Accepted: 14 December 2023
Published: 15 December 2023

Citation: Neha Saraf, M. Natarajan and Mehera Bhoir, 2023. Morphometry of Dry Adult Humeri-A Tertiary Care Centre Study. Res. J. Med. Sci., 17: 325-326, doi: 10.59218/makrjms.2023.12.325.329

INTRODUCTION

The humerus is the longest and largest bone in the upper limb and has expanded ends and a shaft. The rounded head occupies the proximal and medial part of the upper end of the bone and forms an enarthrodial articulation with the glenoid cavity of the scapula. The lesser tubercle projects from the front of the shaft, close to the head and is limited on its lateral side by a well marked groove. The distal end, loosely termed "condylar" is adapted to the forearm bones at the elbow joint[1]. The Latin term "humerus" is closely related to the Greek "omos" meaning shoulder. It later came to refer to the large bone of the upper limb or arm bone[2].

Fractures of the humerus have challenged medical practitioners since the beginning of recorded medical history. In the earliest known surgical text the Edwin Smith Papyrus (copied circa 1600 BC) three cases of humeral fractures were described[3]. Fractures of the humerus are comparatively common and may occur at almost any level. The humerus is fractured by muscular action probably more frequently than any other long bone usually the shaft is broken below the attachment of deltoid. The radial nerve may be injured in its groove or may very rarely become involved later in the growth of callous. Fractures at the proximal end of the humerus may rarely damage the axillary nerve and similarly fractures of the medial epicondyle may be complicated by damage to the ulnar nerve. Supracondylar fractures are relatively common in children the end of the proximal fragments can sometimes injure the brachial artery or median nerve. In adults nonunion is more common in the humerus than in any other long bone[4]. Surgical replacement of the glenohumeral joint has become a routine procedure. Results are improving as new designs of prosthesis are introduced[5].

Hemiarthroplasty represents one type of surgical intervention to replace the detached head of the humerus by shoulder prosthesis. Additional fragments like the greater and lesser tuberosity are attached to the prosthesis stem and to the proximal part of the humerus by wires and sutures[6]. Knowledge of normal as well as variant anatomy of humerus is thus very important and holds great clinical significance in designing prosthesis. Morphometric study of humerus is important for designing of prosthesis and implants for shoulder arthroplasty and elbow arthroplasty and treatment of fractures by intermedullary nailing and fixation and in some other clinical conditions affecting humerus. Morphometric data of humerus can also be used for estimation of age and gender of an individual in forensic cases. The application of osteometric analysis is important in forensic medicine and archaeological practice as well. In this study, we aim to study the morphometry of dry adult humeri and measure the following.

Objectives:

- To measure the maximum length, vertical and transverse diameter of humerus
- To measure the distance between humeral head, greater tubercle and lesser tubercle
- To measure the circumference of shaft of humerus at surgical neck, mid shaft and distal end

MATERIALS AND METHODS

The study was conducted on dry adult human humeri. The humeri were obtained from the bone collection of the department of Anatomy of tertiary care hospitals. Out of total collection of humeri from the department, 150 undamaged humeri were selected for study. The humeri were of undetermined gender and age. Each humerus was assigned a serial number. The humeri were numbered from 1-150. Materials used for measurement of different parameters are as below (Figure 1) The following parameters were recorded.

- Osteometric board
- Digital vernier caliper (precision of 0.01mm)
- Divider
- Measuring scale
- Cotton thread

Maximum length of humerus: It is the distance between the most proximal point on head of humerus to the most distal point on trochlea. It was measured with the help of an osteometric board.

Maximum vertical diameter (supero inferior) of head of humerus: It is the direct distance between the most superior and inferior points on the border of articular surface of head of humerus. It was measured with the help of digital vernier caliper.

Maximum transverse diameter (antero posterior) of head of humerus: This distance is perpendicular to the vertical diameter. It is the maximum width of the head of humerus. It was measured with the help of digital vernier caliper.

Distance between humeral head and greater tubercle: It is the distance between the peripheral limit of articular surface of head of humerus and highest point of greater tubercle. It was measured using divider and scale.

Distance between humeral head and lesser tubercle: It is the distance between the peripheral limit of articular surface of head of humerus and highest point of lesser tubercle. It was measured using divider and scale.

Width of intertubercular sulcus: It is the maximum width between the prominences of greater and lesser tubercle. It was measured using a divider.

Circumference of proximal end of shaft of humerus at surgical neck: It is the upper narrowest circumference of shaft. It was measured using a non elastic thread and scale.

Circumference at mid shaft of humerus: This distance is measured by taking the midpoint of the maximum length of the humerus on osteometric board and measuring the circumference of that point using non elastic thread and scale.

Width of shaft of humerus at distal end: It is the distance measured 2 cm above from the most prominent point on medial epicondyle. It was measured using a digital vernier caliper.

RESULTS

The various parameters were measured in dry human humeri of undetermined gender and age .The results were tabulated and statistically analysed. The observations made after measuring 150 humeri are presented as follows.

Maximum length of humerus: The maximum length of humerus on left side ranged from 258.00-362.00 mm with a mean of 313.47±16.85 mm.

Maximum vertical diameter (supero inferior) of head of humerus (Figure 2): The maximum vertical diameter (supero inferior) of head of humerus on right side ranged from 33.03-51.12 mm with a mean of 42.19±3.98 mm. The maximum vertical diameter (supero inferior) of head of humerus on left side ranged from 33.37-48.32 mm with a mean of 41.88±3.11 mm.

Maximum transverse diameter (antero posterior) of head of humerus: The maximum transverse diameter (antero posterior) of head of humerus on right side ranged from 28.54-44.97 mm with a mean of 38.37±3.39 mm. The maximum transverse diameter (antero posterior) of head of humerus on left side ranged from 30.40-44.58 mm with a mean of 38.18±2.95 mm.

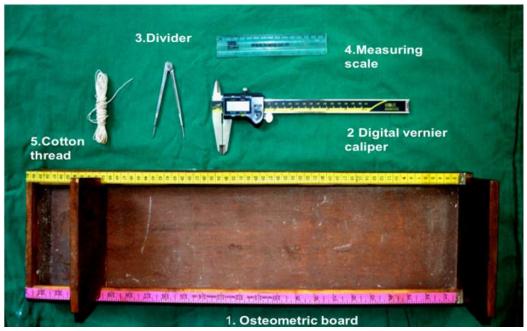

Fig. 1: Showing materials used for measurement

Fig. 2: Illustration showing measurement of vertical diameter of head of humerus

Fig. 3: Showing measurement of width of mid-shaft of humerus

Distance between humeral head and greater tubercle: The distance between humeral head and greater tubercle on right side ranged from 6.00-16.00 mm with the mean of 9.54±1.49 mm. The distance between humeral head and greater tubercle on left side ranged from 8.00-15.00 mm with the mean of 10.14±1.45 mm.

Distance between humeral head and lesser tubercle: The distance between humeral head and lesser tubercle on right side ranged from 8.00-22.00 mm with a mean of 14.52±2.83 mm. The distance between humeral head and lesser tubercle on left side ranged from 10.00-20.00 mm with a mean of 15.20±2.39 mm.

Width of intertubercular sulcus: The width of intertubercular sulcus on right side ranged from 4.00-11.00 mm with mean of 6.60±1.11 mm. The width of intertubercular sulcus on left side ranged from 4.00-10.00 mm with mean of 6.45±1.36 mm.

Circumference of proximal end of shaft of humerus at surgical neck: The circumference of proximal end of shaft of humerus at surgical neck on right side ranged from 54.00-96.00 mm with mean of 74.61±8.23 mm. The circumference of proximal end of shaft of humerus at surgical neck on left side ranged from 54.00-88.00 mm with mean of 75.06±6.67 mm.

Table 1: Maximum length of humerus

Side	No. of bones	Minimum (mm)	Maximum(mm)	Mean (mm)	Standard Deviation
Right	79	270.00	372.00	314.64	20.31
Left	71	258.00	362.00	313.47	16.85

Table 2: Maximum vertical diameter (supero inferior) of head of humerus

Side	No. of bones	Minimum(mm)	Maximum(mm)	Mean (mm)	Standard Deviation
Right	79	33.03	51.12	42.19	3.98
Left	71	33.37	48.32	41.88	3.11

Table 3: Maximum transverse diameter (antero posterior) of head of humerus

Side	No. of bones	Minimum (mm)	Maximum(mm)	Mean (mm)	Standard Deviation
Right	79	28.54	44.97	38.37	3.39
Left	71	30.40	44.58	38.18	2.95

Table 4: Distance between humeral head and greater tubercle

Side	No. of bones	Minimum(mm)	Maximum(mm)	Mean (mm)	Standard Deviation
Right	79	6.00	16.00	9.54	1.49
Left	71	8.00	15.00	10.14	1.45

Table 5: Distance between humeral head and lesser tubercle

Side	No. of bones	Minimum (mm)	Maximu m(mm)	Mean (mm)	Standard Deviation
Right	79	8.00	22.00	14.52	2.83
Left	71	10.00	20.00	15.20	2.39

Table 6: Width of intertubercular sulcus

Side	No. of bones	Minimu m(mm)	Maximu m(mm)	Mean (mm)	Standard Deviation
Right	79	4.00	11.00	6.60	1.11
Left	71	4.00	10.00	6.45	1.36

Table 7: Circumference of proximal end of shaft of humerus at surgical neck

Side	No. of bones	Minimu m(mm)	Maximu m(mm)	Mean (mm)	Standard Deviation
Right	79	54.00	96.00	74.61	8.23
Left	71	54.00	88.00	75.06	6.67

Table 8: Circumference at mid shaft of humerus

Side	No. of bones	Minimum (mm)	Maximu m(mm)	Mean (mm)	Standard Deviation
Right	79	46.00	74.00	58.40	6.72
Left	71	40.00	76.00	58.29	6.24

Table 9: Width of shaft of humerus at distal end

Side	No .of bones	Minimu m(mm)	Maximu m(mm)	Mean (mm)	Standard Deviation
Right	79	22.50	46.08	34.51	5.69
Left	71	24.43	44.00	35.23	4.77

Circumference at mid shaft of humerus (Figure 3): The circumference at mid shaft of humerus on right side ranged from 46.00-74.00 mm with a mean of 58.40±6.72 mm. The circumference at mid shaft of humerus on left side ranged from 40.00-76.00 mm with a mean of 58.29±6.24 mm.

Width of shaft of humerus at distal end: The width of shaft of humerus at distal end on right side ranged from 22.50-46.08 mm with a mean of 34.51±5.69 mm. The width of shaft of humerus at distal end on left side ranged from 24.43-44.00 mm with a mean of 35.23±4.77 mm.

DISCUSSIONS

Several quantitative anatomical studies have been carried out for the humeri in different countries. Many authors have studied the various parameters of humeri using different methods such as Computed Tomography (CT) scans, Magnetic Resonance Imaging (MRI) scans, plain radiographs, direct specimen measurements and quantitative 3-dimensional anatomic techniques.

Maximum length of humerus: When compared with studies like Udhaya *et al.*[6] Somesh *et al.*[7] Rahul Rai *et al.* the mean maximum length of humerus in the present study is slightly greater that of the remaining studies.

Maximum vertical diameter (supero inferior) of head of humerus: The mean maximum vertical diameter of head of humerusin the present study is comparable with the previous studies by Girish Patil *et al.*[9] Kudhaya *et al.*[6] Rahul Rai *et al.*[8].

Maximum transverse diameter (antero posterior) of head of humerus: The mean transverse diameter of head of humerus is comparable with the study of Devi *et al.*[10]. The findings in the present study are higher than the findings in Gayatri *et al.*[12].

Distance between humeral head and greater tubercle: The result of the present study is slightly more than the previous studies by Devi *et al.*[10] and Rahul Rai *et al.*[8]. In anatomic studies it was reported that the highest point on the articular segment of the humeral head is

found 6-8 mm above from the most proximal point of the greater tuberosity and findings in our study is only slightly more than that. This relationship is important because the relative height of the greater tuberosity determines the amount of subacromial clearance when arm is elevated. Moreover in clinical assessment his point is important for the treatment of isolated greater tuberosity fractures.

Distance between humeral head and lesser tubercle: In the present study the distance between humeral head and lesser tubercle was on right side ranged from 8.00-22.00 mm with a mean of 14.52±2.83 mm and on the left side ranged from 10.00-20.00 mm with a mean of 15.20±2.39 mm. There was no comparable study available in the literature reviewed. Hence the results of the present study can be used for comparison with the values in future studies measuring distance between humeral head and lesser tubercle. Moreover, measurements of proximal humerus segments becomes important in cases of proximal humeral fractures, which extends along the epiphyseal lines of proximal humerus and its segments, causing their displacement to various degrees.

Width of intertubercular sulcus: The mean width of the intertubercular sulcus in the present study is comparable with the findings of Kishwe *et al.*[12]. This parameter is very important as the biceps tendon is enshrined in bicipital groove (intertubercular sulcus) width may influence the pathology occurring in this tendon. In wider groove the tendon is freer to move and there are less chances of tendon getting damaged.

Circumference of shaft of humerus at surgical neck: The mean circumference of shaft of humerus at surgical neck in present study is more than the findings in Devi *et al.*[10] and Anudeep Singh *et al.*[11].

Circumference of midshaft of humerus: The mean circumference of mid shaft of humerus in present study is in accordance with the findings of previous study by Anudeep *et al.*[11].

Width of shaft of humerus at distal end: The mean width of shaft of humerus at distal end in present study is lower than that found in Devi *et al.*[10].

CONCLUSION

The present study provides a comprehensive data about the morphometry of human humeri which will help in designing implants and instrumentations and also provides data regarding quantitative anatomy of humerus. The differences in the results of the present study and those of the previous studies with respect to some of the parameters may be due to differences in race, ethnicity, environmental factors as well as methods used for the studies.

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