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Morphometric Study of Endosteal Diameter of the Surgical Neck of Humerus through Digital Radiographic Analysis

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Abstract

Endosteal diameter at the surgical neck of the humerus is a very important parameter in shoulder arthroplasty in terms of designing its prosthesis. A cross-sectional, analytical study was carried out in the Department of Anatomy, Dhaka Medical College, Bangladesh, from January to December of 2019, to observe the gender variation of the endosteal diameter of the surgical neck of the humerus in the adult Bangladeshi population through digital radiographic analysis. This study was performed by analyzing digital radiographs of left shoulder joint of 100 subjects (50 male and 50 female) attending the Radiology & Imaging of the same institution (aged between 26 and 49 years). They were selected based on our inclusion and exclusion criteria by adopting convenient purposive sampling method. After taking digital x-ray, those images were transferred to a computer. Diameter from those radiographs were then measured by using computer software named 'MB-Ruler'. The mean endosteal diameters of the surgical neck of the humerus among Bangladeshi male and female were found 18.21±2.25 mm and 15.07±2.20 mm respectively. The range of the endosteal diameter at the surgical neck of the humerus was from 14.29 mm to 26.83 mm in male and from 8.94 mm to 19.35 mm in female. The mean value was higher in male comparing to its female counterpart ($p<0.001$).

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Introduction

The shoulder joint consists of an articulation between the head of the humerus and the glenoid cavity of the scapula. It is a multiaxial synovial ball and socket joint that functions as a diarthrosis.[1] The glenohumeral joint is suited for extreme mobility with its mismatched large humeral head and small glenoid articular surface of the scapula.[2] The shoulder is the most flexible joint in the body, making it the most susceptible to instability and injury.[3] The instability is compensated by rotator cuff muscle tendons, ligaments, and glenoid labrum.[4] Stability across the glenohumeral joint is balanced by both static and dynamic mechanisms.[5,6]

The surgical neck is the narrow part distal to the head and greater and lesser tubercles.[7,8] The surgical neck region is oriented in the horizontal plane between the expanded proximal part of the humerus (head, anatomical neck, and tubercles) and the narrower shaft. Because the surgical neck is weaker than more proximal regions of the bone, it is one of the sites where the humerus commonly fractures.[7,8]

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The endosteum is the tissue lining all inner aspects of the bones, including the medullary cavity.[8] It is a thin osteogenic layer that is lined with osteoblasts and precursors to oteoblasts. In times of inactivity, these cells are flat and are not easy to distinguish from each other. Upon activation, osteoblasts become cuboidal and are capable of producing osteoid, which forms new lamellar bone. The endosteal layer covers all the trabeculae of spongy bone along with the inner cortical surface to which the trabeculae are attached. It also invaginates the perforations that allow the passage of blood vessels and continues into the cortical bone where it lines the perforating canals (Haversian and Volkmann's canals).[8] The two osteogenic layers, endosteum and periosteum, are responsible for the balance of bone deposition and resorption. Bone resorption is often greater than bone deposition and thus the marrow cavity expand as we age.[8]

The countries (like the USA, Japan, and the UK) with a prosthesis industry design and manufacture prostheses primarily according to the morphometric data of the population of their own country. However, these prostheses are used in populations of countries with different ethnic and morphological characteristics, and there is generally an incompatibility between the prosthesis and the morphometric data of the population where they are used.[6,9] As a result of this incompatibility and curettage of the bone structure, associated loss of tissue develops which has negative effects on clinical progress and success. These problems could be overcome if the countries with a prosthesis industry produced prostheses appropriate to the morphometric features of countries with different ethnic characteristics.[6,10] Variations of the endosteal diameter at the surgical neck of the humerus have an influence on the geometry of the glenohumeral joint. In this study, the endosteal diameter at the surgical neck of the humerus was measured based on standard radiographs of the antero-posterior view of the shoulder joint with no osseous lesions.[11]

Besides, the measurement of the endosteal diameter of the surgical neck of the humerus of adult Bangladeshi males and females will be helpful to the anatomists for a normative reference. Radiographic data of the endosteal diameter at the surgical neck of the humerus are essential for the proper designing of shoulder joint prosthesis by the ergonomist and for surgical reconstruction by the orthopaedic surgeons.

With the above perspectives, the present study was designed to obtain standard radiographic data of the endosteal diameter at the surgical neck of the humerus for understanding shoulder joints in the normal adult Bangladeshi population and to construct baseline data of the same population.

Methods

This cross-sectional, analytical study was carried out in the Department of Anatomy, Dhaka Medical College, Bangladesh, from January to December of 2019. Adult Bangladeshi people attending the Department of Radiology & Imaging of the same institution were the population of the study. A total of 100 people were included in the study based on our inclusion and exclusion criteria by adopting convenient purposive sampling method. Any person having surgery, fracture, dislocation, arthritis, etc. of the left shoulder joint and any pregnant lady were excluded from the study. The subjects were divided into two groups (50 male and 50 female) to observe the gender variation, if any. The selected subjects were requested for taking standard radiographs of the antero-posterior view of the left shoulder joint.

The age of the subjects was within the range of 26 to 49 years. The reason behind selecting this age limit is that the process of ossification of the humerus, including its upper end, is completed by the 20th year, that of the scapula completes about the 25th year of life, and early degenerative changes of the humerus and scapula begin from 50th year of life.[13] Digital radiographic images of the left shoulder joint were taken by digital x-ray machine and transferred to a computer. Measurements of the endosteal diameter at the surgical neck of the humerus were then taken by using the computer software named 'MB -Ruler'.

Procedure of measurement of endosteal diameter of surgical neck of humerus: At the surgical neck, the medial inner cortical margin was identified with a blue dot marked by A. Then, the lateral inner cortical margin was identified with a red dot marked by B at the same level. Then, a line was drawn from the point A to the point B. The length of this line AB was measured by MB-Ruler software. It was measured on standard anteroposterior view.[12] (Fig. 1).

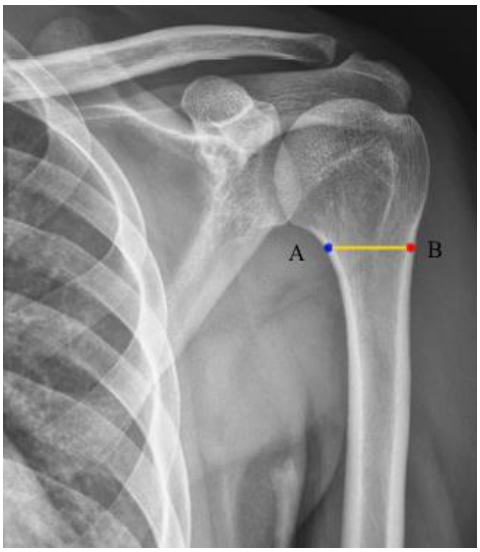

Fig. 1: Measurement of endosteal diameter at the surgical neck of humerus; A- Medial inner cortical margin at the surgical neck; B- Lateral inner cortical margin at the surgical neck; AB- Endosteal diameter at the surgical neck of the humerus

Following data collection, data input was done. The collected data was assessed for completeness, accuracy, and consistency before analysis. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 20.0 for windows.

Data was expressed as mean±standard deviation (SD). Comparison between male and female was done using Unpaired Student's t-test. A p-value <0.05 was considered as statistically significant. The data were presented in table and graph.

Ethical clearance was obtained from the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

Results

In our study, a total of 100 adult Bangladeshi people were included (50 male and 50 female). In male, the mean endosteal diameter at the surgical neck of the humerus was found 18.21±2.25 mm (ranging between 14.29 mm and 26.83 mm). In female, the mean endosteal diameter at the surgical neck of the humerus was found 15.07±2.20 mm (ranging between 8.94 mm and 19.35 mm). The value was significantly higher in male comparing to its female counterpart (p<0.001) (Table-I, Fig. 2).

Table I: Endosteal diameter at the surgical neck of humerus (N=100)

Variables in mm	Male (n=50) Mean±SD	Female (n=50) Mean±SD	p-value
Endosteal diameter of surgical neck of humerus	18.21±2.25 (14.29–26.83)	15.07±2.20 (8.94–19.35)	0.000*

Figures in parentheses indicate range; comparison between male and female was done by Unpaired Student's 't' test; *= Significant (p<0.001).

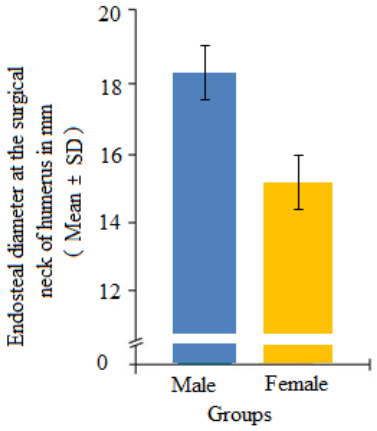

Fig. 2: Endosteal diameter at the surgical neck of humerus

Discussion

In the present study, the mean endosteal diameter at the surgical neck of the humerus was found significantly higher in male than that of female ($p<0.001$). Iyem *et al*. (2017) conducted a study comprising 195 patients' (101 male and 94 female) plain shoulder radiographs. They also found that the endosteal diameter at the surgical neck of the humerus was significantly higher in males than females ($p<0.01$).[12] Meanwhile, Sintini *et al.* (2018) examined 84 radiographs of the left humerus (38 female and 46 male) and found that the endosteal diameter of the surgical neck of the humerus was significantly higher in male than that of female ($p<0.05$).[10] Therefore, our finding are similar to the findings reported by Iyem, *et al.* (2017) and Sintini, *et al.* (2018).[12,10]

Prosthesis designers have identified several important anatomical and biomechanical factors, including humeral head and neck's size and shape, neck-shaft angle and version.[13] Besides, we appreciate the ethnic differences of height and size across the globe.[14] Our data, therefore, seems to be useful in prosthesis design for Bangladeshi people.

This study has several limitations. All participants were from a single hospital, and the sample size was small, which may limit generalizing the finding on targeted population. Moreover, the subjects were selected through purposive sampling which may induce bias.

Conclusion

Our study found that the mean endosteal diameters of the surgical neck of the humerus in Bangladeshi male and female were 18.21±2.25 mm and 15.07±2.20 mm respectively; the difference also statistically significant.. The data obtained from digital radiographs may be used in designing shoulder joint prostheses. Our study may also provide a starting point for further investigations on morphometry (of the whole of the upper end or partly) of the humerus using digital radiographs of shoulder joints in Bangladeshi and other populations as well.

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