ORIGINAL ARTICLE

Variations in Gross Anatomical Parameters of Proximal End of Humerus: A Useful Guideline for Developing Shoulder Prosthesis

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ABSTRACT

Background: Humerus is one of the long bones of body having a proximal or upper end involved in shoulder joint, lower end forming elbow joint and its shaft forming arm. Maintenance of optimal gleno humeral articulation is crucial for wide range of movements taking place at shoulder joint. Accurate comprehension of its anatomy is mandatory for its anatomic reconstruction in cases of fracture of proximal end of humerus, osteoarthritis of shoulder joint and surgeries where prosthesis implant is applied.
Aim: To provide morphometric data of cadaveric humerii to help in designing age, gender and ethnicity specific prosthesis and to achieve better kinematics in patients.
Methodology: 196 unpaired humerii were measured via vernier caliper and tapeline.
Results: Results obtained for proximal humeral end parameters supported the need for further improvement in implant design.
Conclusion: The strength of this study is the large number of postmortem samples. The results obtained will help systematically improve implant design and anchorage.
Key words: Humerus, Vernier caliper, Tapeline

INTRODUCTION

Humerus is one of the long bones of body forming shoulder, arm and elbow. It consists of an upper or proximal end, a shaft and a lower or distal end. Proximal end of humerus participates in the formation of shoulder joint. It is an angulated non-weight bearing end consisting of humeral head and proximal shaft portion. Caput of humeral head is directed on medial side and articulates with glenoid cavity formed by scapula[1]. This glenohumeral articulation allows a wide range of movements in multiple directions. The anatomical neck separates the caput from lesser and greater tuberosities. Below the head is surgical neck which separates head from shaft. There is a groove between lesser and greater tuberosities which extends to the upper one-third of the shaft of humerus. This is bounded by two elevated bony lips hence called the bicipital groove. Understanding of normal morphology of humerus is important since the recreation of normal anatomy is required in prosthetic replacements of upper end of humerus[2]. Its accurate comprehension is crucial for anatomic reconstruction in shoulder arthroplasty[3]. Restoration of proximal humeral anatomy is very important for the postoperative clinical outcomes in surgeries for prosthesis implant in the treatment of glenohumeral osteoarthritis, fractures of proximal humerus, rotator cuff arthropathy and tumor resection[4].

Anatomical parameters measured for designing implants are based on radiological measurements. In radiography we have X-rays and three-dimensional computed tomography. Three-dimensional computed tomography has more reproducible results as compared to X-rays[5]. This technique has been devised to cover the lack of availability of actual human cadaveric specimen as this requires a larger sample size for getting statistically significant results. Anatomical measurements taken from original specimen are more accurate than radiological measurements[6]. All the parameters measured radiologically have slightly lesser values than the anatomical measurements [7]. The Swedish Fracture Register in 2016, 79% were proximal, 13% shaft and 8% distal humeral fractures[8]. Proximal humeral fractures are the third most common osteoporotic fracture type observed in elderly patients. Its incidence increases with aging and causes morbidity among them with burden on health care resources as well[9]. Complex proximal humeral fractures are challenging regarding reduction and stability postoperatively[10].

METHODOLOGY

196 unpaired dry humerii were studied from the collection of bones from the Anatomy Department, KEMU, Lahore without age and sex discrimination. Digital vernier caliper and a tapeline were used for measurement. Following measurements were taken i.e. head circumference (anatomical neck of humerus), anteroposterior head diameter, transverse head diameter, distance between the most proximal point of humeral head and the most prominent point on greater tuberosity, distance between the most proximal point of humeral head and lower margin of surgical neck of humerus.

Statistical analysis was performed using SPSS version 20. All the measurements of 196 humerii were performed independently by the main examiner within an interval of one week. Data was analyzed in descriptive statistics and reported as mean ± SD.

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RESULTS

The detail of results is given in table 1.

Table 1:

	n	Minimum	Max.	Mean	SD
Head circumference (anatomical neck)	186	108	163	1.4	8.6
Antero-posterior head diameter	174	25.9	51.4	40.4	3.2
Transverse head diameter	196	8.7	27.8	16.4	3.7
Humeral head to Greater Tuberosity	184	5.2	15.4	10.4	1.8
Humeral head to Surgical neck	196	23.9	55.4	44.9	3.9

DISCUSSION

A study carried out in 2018 by anatomists of Malaysia, India and Oman, morphology of humerus shows greater variations in different populations due to genetics, environmental factors and life style differences influencing the general built of people in different geographic locations of the world having variable eating habits and vocations.[21] Our study provides actual human cadaveric measurements of various morphological parameters of humerus from a very large sample size i.e. 196 dried unpaired humerii. Anatomical parameters measured here are of considerable importance for shoulder surgeries and implant design and optimization. If prosthesis head is placed too low relative to the tuberosity, it leads to subacromial impingement. If placed too high, abduction would be limited due to tightening of inferior capsule which could impair shoulder function. Thus dysfunction of shoulder joint may be caused by improper choice and placement of prosthesis during surgery.

There is variability in the geometry of long bones i.e. humerus, femur etc across different geographical locations and ethnic groups [11]. The osteological parameters are very important for designing prosthesis used for surgeries [12]. Best fit implants are often not available due to differences in statistical shapes and sizes of humerii between western and asian population[13]. Currently available implants in the market are based on data obtained from western population only and are not suitable for Asian patients who exhibit variation in sizes and shapes[14].

In a study carried out in 2017, radiographic assessment of prosthetic humeral heads was done after shoulder arthroplasty. Out of 168 cases, 67 were regarded as outliers due to deviation of head resulting in functional impairment. This was due to improper humeral head size selection. There is also age dependent variation of gleno humeral parameters in healthy individuals. Increased size of humeral head and glenoid surface has been present in older patients without any signs of osteoarthritis along with increased glenoid to head ratio. This age dependent variation also needs to be taken into account while planning for operative procedures of shoulder joint [15].

Contour of bicipital groove offers a useful landmark for humeral head replacement in fractures of proximal end of humerus. It contains tendon of the long head of biceps brachii muscle which plays a very important role in maintaining the alignment of the head of humerus within the glenoid cavity of scapula. Various surgical procedures for shoulder reconstruction use bicipital groove as landmark which helps re-establish shoulder function after complex humeral fractures.

CONCLUSION

This study supports the need for further development of humeral implants. The results obtained will help systematically improve implant design and anchorage.

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