

# MORPHOMETRIC EVALUATION OF DRY HUMERUS BONE IN A MEDICAL COLLEGE OF EASTERN NEPAL

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## ABSTRACT

### Introduction

Anthropometric measurement of dry bones are helpful to estimate the stature. It is useful for differentiating unidentified bodies, skeletal remains, surgical procedures and are helpful for anthropologists, anatomists, forensic and surgery.

### Objective

The objective of this study was to find the morphometric measurements of dry Humerus bone available at Birat Medical College and Teaching Hospital of Eastern Nepal.

### Methodology

A cross-sectional study was conducted from 28th June- 28th July 2019 in the department of Anatomy of Birat Medical College and Teaching Hospital by taking 59 dry humerus bone. Various parameters such as maximum length, circumference of surgical neck, epicondylar breadth together with position and number of nutrient foramina were measured. Data was collected using osteometric board, vernier caliper and tape. The number, direction and location of nutrient foramina were observed macroscopically by using a fine wire. Ethical clearance was taken from Institutional Review Committee of Birat Medical College and Teaching Hospital.

### Results

Among 59 dry humerus bone, majority (32) were left humerus. No statistical significant difference was found in morphometric measurements between right and left side of dry Humerus bone. The single nutrient foramen was present in 85.18% and 81.25% of right and left humeri respectively. Double nutrient foramina in 14.81% of right humeri and 15.62% of left humeri. Triple nutrient foramina was only seen in left humeri (3.12%).

### Conclusion

Single nutrient foramen is most common in both sides of humeri. No statistical significant difference was found between right and left humeri in the different parameters such as maximum humeral length (MHL), vertical diameter of superior articular surface (VDSAS), circumference of surgical neck (CSN), circumferences of middle shaft (CMS), epicondylar breath (EB), medial epicondyle to capitulum (ME - C), transverse diameter inferior articular surface (TDIAS), maximum transverse diameter of trochlea (MTDT), anteroposterior diameter of the trochlea (APDT) and position of nutrient foramina (PNF).

## KEYWORDS

Humerus, morphometry, nutrient foramen



## INTRODUCTION

Humerus is the longest and strongest bone of the upper extremity. Anatomically, it is located between the two joints: elbow and shoulder. It presents upper and lower ends, and an intervening shaft that exists as part of the shoulder joint and facilitates mobility. Humerus, in addition, forms the elbow joint. It articulates with several skeleton components in several ways, such as it articulates with ulna as hinge, radius as ball & socket, capitulum as ball and head of the radius as socket.<sup>1</sup> So, in anatomical point of view, Humerus facilitates different types of movements at upper limb. Surgical neck of humerus is a unique feature that no other long bones possess. In devoid of pelvis and cranium, morphometric analysis is usually done in the remains of the long bones of an individual in anthropology and forensic science studies.<sup>2</sup> Celbis et, al also stated that in case of absence of lower limb bones the estimation of living stature can be done by remains of upper limb bones such as humerus, radius and ulna.<sup>3</sup> Anthropometric measurement have been frequently used to estimate the stature from bones and plays vital role in differentiating unidentified bodies, part of bodies or skeletal remains by anthropologists, medical scientists and anatomists for over hundred years.<sup>4</sup> The knowledge of knowing the mean values of Humerus segments is very important for anatomist and forensic experts and helps the investigator to define the identity of skeleton.<sup>5,6</sup> Nutrient foramen is an opening in the shaft of Humerus. It steers to oblique nutrient canal passing through cortex and finally open into the medullary cavity.<sup>7</sup> The nutrient artery enters into medullary cavity through nutrient foramen and the canal which is major source of blood supply to medullary cavity and inner two-third of cortex of the bone and play for an important role in fracture healing.<sup>8</sup> Additionally, the presence of preserve nutrient blood supply is necessary for the survival of the osteocytes in cases of tumor resection, trauma and congenital pseudoarthrosis.<sup>9</sup> It is generally single and situated on antero-medial surface of the humerus near to the midpoint of medial border.<sup>10</sup> The number and position of foramina varies and may change during the growth of long bones.<sup>11</sup> The morphometry of humerus, it's number and location of nutrient foramina are variable between different individuals with different races.<sup>12</sup> Hence this study explore the morphometry of adult humeri of Nepalese subjects which may be useful to anatomists, forensic experts and orthopaedician performing procedures involving bone grafts, fracture repair, joint replacement and vascularised bone microsurgery. Awareness of the number and position of nutrient foramina is beneficial in many surgical procedures. Many studies have been conducted focusing on morphometric measurements of humerus.<sup>13</sup> They calculated different measurements of humerus and compared the results between both side. However, we could not find any literatures and published articles regarding morphometric measurements of humerus in Nepal. Therefore, the objective of this study is to find the morphometric evaluation of dry humerus bone available at Birat Medical College and Teaching hospital.

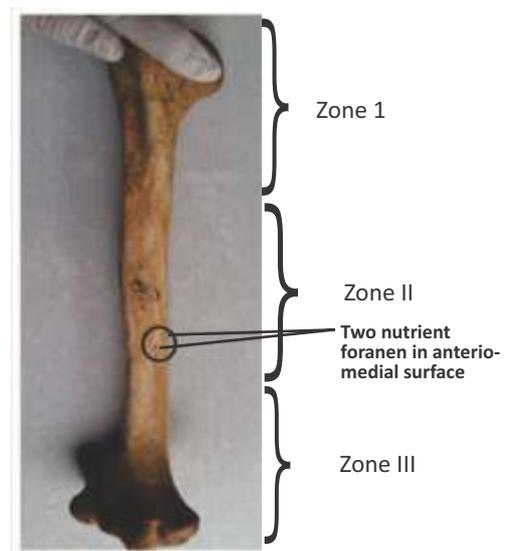
## METHODOLOGY

A cross sectional study conducted from 28th June - 28th July 2019 on dry humerus bones of unknown sex ( $n=59$ : 27 right and 32 left side) available at laboratory of Department of Anatomy of Birat Medical College and Teaching Hospital. Ethical clearance was taken from Institutional Review Committee of Birat Medical College and Teaching Hospital. The data were analyzed by using Statistical Package for the Social Sciences (SPSS) version 23. Vernier caliper, osteometric board, measuring tape and fine wire were used for identification of nutrient foramen. The operational definition of parameters are given in table 1.

**Table 1: Morphological Parameters of Humerus**

SN	Parameters	Description
1	Maximum humeral length (MHL)	The distance between the most proximal point of head to most distal point of trochlea of Humerus
2	Vertical diameter of superior articular surface (VDSAS)	Maximum diameter of superior articular surface
3	Circumference of surgical neck (CSN)	The circumference located in the lower point of the Humeral head
4	Circumferences of middle shaft (CMS)	Maximum diameter at the middle shaft
5	Epicondylar breadth (EB)	Transverse distance between lateral epicondyle to medial epicondyle
6	Medial epicondyle to capitulum (ME-C)	Distance between the Medial margin medial epicondyle to lateral margin of capitulum (ME-C)
7	Transverse diameter inferior articular surface (TDIAS)	Medial margin of articular surface of trochlea to lateral margin of capitulum
8	Maximum transverse diameter of trochlea (MTDT)	Distance between medial and lateral margin of trochlea
9	Anteroposterior diameter of the trochlea (APDT)	Distance between anterior margin of trochlea to the posterior margin of trochlea
10	Position of nutrient foramina (PNF)	Distance of nutrient foramina from upper end

On the surface of bone, a groove was presents adjacent to the nutrient foramen that appeared to continue into it. Location and direction of nutrient foramen in relation with surface and zone were observed and recorded. The position of foramina was divided into three types of zone (Zone I: Foramen present in the upper one third of the bone, Zone II: In the middle one third of the bone, Zone III: In the lower one third of the bone) as shown in figure 1 and other measurement as shown in figure 2 and figure 3.



**Figure 1:** Right humerus showing different zones and location of nutrient foramen



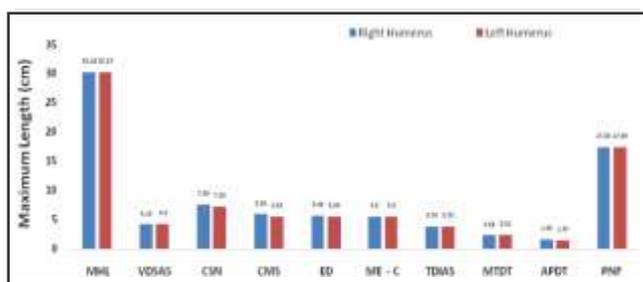
**Figure 2:** Measurement of vertical diameter of superior-articular surfaces of humerus



**Figure 3:** Measurement of the transverse diameter of inferior articular surface of humerus

**RESULTS**

Fifty-nine dry humerus bone are used for the study. Among them 27 right and 32 left sided humerus identified. The maximum length of each parameter are shown in figure 4.



**Figure 4:** Maximum length of all parameters of right and left humerus

\* Maximum humeral length (MHL), Vertical diameter of superior articular surface (VDSAS), Circumference of surgical neck (CSN), Circumferences of middle shaft (CMS), Epicondylar breath (EB), Medial epicondyle to capitulum (ME - C), Transverse diameter inferior articular surface (TDIAS), Maximum transverse diameter of trochlea (MTDT), Anteroposterior diameter of the trochlea (APDT), Position of nutrient foramina (PNF).

The mean and standard deviation are shown in table 2. Right and left humerus was compared for all parameters. As p values of comparative data were >0.05, the difference between humeri of both sided with respective concerned parameters were insignificant.

**Table 2:** Showing mean and standard deviation of different parameters in cm of right and left humeri

SN	Parameters*	Right sided Mean and SD in centimeter(cm)	Left sided Mean and SD in centimeter(cm)
1	MHL	30.26±1.63	30.27±2.01
2	VDSAS	4.19±0.37	4.30±0.57
3	CSN	7.59±0.78	7.24±0.83
4	CMS	5.89±0.75	5.53±0.5
5	ED	5.66±0.83	5.54±0.55
6	ME-C	5.50±0.61	5.50±0.49
7	TDIAS	3.79±0.43	3.75±0.33
8	MTDT	2.33±0.18	2.41±0.22
9	APDT	1.58±0.24	1.47±0.15
10	PNF	17.38±2.42	17.39±1.57

\* Maximum humeral length (MHL), Vertical diameter of superior articular surface (VDSAS), Circumference of surgical neck (CSN), Circumferences of middle shaft (CMS), Epicondylar breath (EB), Medial epicondyle to capitulum (ME - C), Transverse diameter inferior articular surface (TDIAS), Maximum transverse diameter of trochlea (MTDT), Anteroposterior diameter of the trochlea (APDT), Position of nutrient foramina (PNF).

The nutrient foramina were present in all humeri. The direction of nutrient foramina was not showing any variation from normal anatomical feature. All the foramina were directed downward or toward the lower end of humeri. The variation in number of foramina and their respective zone is shown in table 3 and table 4 respectively. Nutrient foramina found in right and left humerus are 31 and 39 respectively. The majority of nutrient foramina is located in antero-medial surface of humerus.

**Table 3:** Position of nutrient foramina at different zones of humerus

Position of nutrient foramen	Right side		Left side		Both right & left	
	Number of Bone	Number of nutrient foramen	Number of Bone	Number of Nutrient foramen	Number of bone	Foramen in Zone %
Zone I	1	1	0	0	1	1.69
Zone II	24	28	28	35	52	88.13
Zone III	2	2	4	4	6	10.16
Total	27	31	32	39	59	100



**Table 4:** Distribution of nutrient foramen in humerus

Side & Number of bone	Number of nutrient foramen (%)			
	Absent	Single	Double	Triple
Right (n=27)	0	23 (85.18%)	4(14.81%)	0
Left (n=32)	0	26 (81.25%)	5 (15.62%)	1(3.12%)
Total (n=59)	0	49 (83.05%)	9 (15.25%)	1 (1.69%)

## DISCUSSION

Knowledge of the morphometric values of humerus is important in forensic, anatomy and archeology. It is also helpful for the clinician in the treatment of proximal and distal humerus fractures. This study analyzed dry humerus bone available at our Department of Anatomy of Birat Medical College and Teaching Hospital. Many studies have been conducted focusing on morphometric measurements of humerus.<sup>13</sup> In this present study mean value of the maximum Humerus length (MHL) of right and left side was  $30.26 \pm 1.63$  and  $30.27 \pm 2.01$  cm respectively without significant statistical difference. Similar findings were reported in studies conducted at Gujarat Indian population, Brazilian population and Turkey population<sup>14-16</sup> but significant difference was found in the studies conducted at Karnataka Indian population.<sup>17</sup> In this study, mean value of maximum vertical diameter of superior articular surface (VDSAS) of right and left humerus was  $4.19 \pm 0.37$  and  $4.30 \pm 0.57$  cm respectively and no significant statistical difference found. Similar findings were reported in studies conducted at Turkey population.<sup>16</sup> Circumferences of middle shaft (CMS) of our study is lesser than studies conducted at Chinese and Japanese population.<sup>18</sup> Environmental factors, lifestyle, nutrition, occupation and genetic factor impacts the variation of dimension.<sup>19</sup> In this study, the mean value of epicondylar breath (EB) of right and left humerus was  $5.66 \pm 0.83$  and  $5.54 \pm 0.55$  cm respectively without statistical significance. Similar finding were reported in other studies.<sup>14,15,20</sup> In this study, the mean value of medial epicondyle to capitulum (ME-C) of right and left humerus was  $5.50 \pm 0.61$  and  $5.50 \pm 0.49$  cm respectively without statistical significance. Similar finding were reported in other studies.<sup>14,15</sup> In this study, the mean value of Transverse diameter inferior articular surface (TDIAS) of right and left humerus was  $3.79 \pm 0.43$  and  $3.75 \pm 0.33$  cm respectively without statistical significance. Similar findings were reported in other study<sup>15</sup> but in those study statistically significant difference found in the left humerus.<sup>14</sup>

In this study, the mean value of maximum transverse diameter of trochlea (MTDT) of right and left humerus was  $2.33 \pm 0.18$  and  $2.41 \pm 0.22$  cm respectively without statistical significance. Similar findings were reported in other study<sup>15</sup> but in another study statistical significant difference found in the left humerus.<sup>14</sup> In this study, the mean value of anteroposterior diameter of the trochlea (APDT) of right and left humerus was  $1.58 \pm 0.24$  and  $1.47 \pm 0.15$  cm respectively without statistical significance but in those studies

statistically significant difference was found in the right humerus<sup>14</sup> and left humerus.<sup>15</sup> Acquiring the knowledge of variations of nutrient foramina may help orthopedicians to avoid injury of nutrient artery when performing open reduction thus reducing the chances of delayed or non-union of the fracture.<sup>21</sup> In spite of optimal treatment some fractures heal slowly or fail to heal because of severity of the injury, poor blood supply, age and nutritional status of the patient or other factors.<sup>22</sup> There is maximum chance of injury to nutrient artery during the open reduction of fracture of mid-shaft.<sup>23</sup> Our present study found single nutrient foramen in 83.5% of dry humerus. Similar finding (83.3%) was reported in another study carried out in Nepalese population.<sup>11</sup> Other studies from different parts of world reported were, north Indian population (80.86%),<sup>24</sup> Southern Brazil population (88.5%),<sup>25</sup> Uttar Pradesh of India (90%)<sup>26</sup> and Indian population (58%).<sup>27</sup> Our present study found double nutrient foramina in 15.25% of dry Humerus. Similar findings were reported from studies conducted at Nepalese population (15%)<sup>11</sup> and at Indian population (17.5%).<sup>28</sup> In our study, majority (88.13%) of nutrient foramina were found in the middle one-third (zonell) of the shaft of the humeri. Almost similar findings of nutrient foramina were reported by Rajeev et al (86.66%), Mansur DI et al (94.84%) in Nepalese population, Khan As et al (96.2%) in Pakistani population and Halagatti et al (84%) in Indian population.<sup>11,28,29,30</sup>

## CONCLUSION

Single nutrient foramen is most common in both sides of humeri. No statistical significant difference was found between right and left humeri in the different parameters such as maximum humeral length (MHL), vertical diameter of superior articular surface (VDSAS), circumference of surgical neck (CSN), circumferences of middle shaft (CMS), epicondylar breath (EB), medial epicondyle to capitulum (ME - C), transverse diameter inferior articular surface (TDIAS), maximum transverse diameter of trochlea (MTDT), anteroposterior diameter of the trochlea (APDT) and position of nutrient foramina (PNF).

## LIMITATIONS OF THE STUDY

We were not able to compare sex, age and race factor with different morphometric parameters.

## RECOMMENDATIONS

More sociodemographic variables and large sample study need to be done to find different morphometric parameter in our setting.

## FINANCIAL DISCLOSURE

The authors would like to declare no financial assistance for this study.



**CONFLICT OF INTEREST**

The authors would like to declare no conflict of interest.

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