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Original Research Article

MORPHOMETRIC AND MORPHOLOGICAL STUDY OF THE NUTRIENT FORAMINA IN DRY HUMAN HUMERUS BONES OF TELANGANA REGION

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ABSTRACT

Introduction: The foramina which leads into a canal on the shaft, through which the vessels enter to supply the medullary cavity is called nutrient foramina. The major source of blood supply during the bone growth and development is by nutrient artery.

Materials and methods: The study was conducted on 218 adult humerii. The number, direction and location of nutrient foramen were observed with the help of a hand lens. The Total length of humerus, distance of the nutrient foramen from its upper end, Location of the nutrient foramen with respect to the surfaces, zones and the foramen index were noted.

Results: It was observed that 81.19% of the humeri had a single nutrient foramen, 18.35% double foramen, 0.45% triple foramen, where as 3.67% humeri did not have any nutrient foramina. The majority (82.11%) of the nutrient foramina were present on the antero-medial surface, 14.22% on the medial border and 9.63% on the antero-lateral surface,7.8%on the posterior border and 0.46% on anterior border of the shaft of humeri. The foramen index was observed to be 56.35 ±7.36 on right side and 55.57±8.5 on left side, indicating the zonal distribution of foramina in the middle third of the bone.

Conclusion: With the increasing number of fracture cases due to various causes, the knowledge of nutrient foramina is of much importance in bone reduction and grafting techniques. The present study adds to the existing data on nutrient foramina especially in the population of Telangana region.

KEY WORDS: Humerus, Nutrient Foramina, Nutrient Artery, Foramen Index.

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INTRODUCTION

Bones possess many a foramina for the entrance of the blood-vessels, which nourish the entire bone; Long bones are typically supplied by

foursets of blood vessels called, nutrient artery, epiphyseal, metaphyseal and periosteal arteries. Out of the many foramina, the one which leads into a canal on the shaft, through which the vessels enter to supply the medullary cavity are called nutrient foramina. The major source of blood supply during the bone growth and development is by nutrient artery. Usually the site of entry and direction of the nutrient foramina is constant and is directed away from the growing end of the bone [1]. With the increasing number of fracture cases due to various causes, the knowledge of nutrient foramina is much of importance in bone reduction and grafting techniques.

MATERIALS AND METHODS

The study was conducted on 218 adult humerii collected from Department of Anatomy,Mamata medical college, Telangana. Damaged and pathologically deformed bones were excluded from the study.

The number, direction and location of nutrient foramen were observed with thehelp of a hand lens.

The following parameters were noted

· Total length of the humerus and the distance of the nutrient foramen from its upper end.

· number and size of the nutrient foramina

· Location of the nutrient foramen with respect to the surfaces,zones and the foramen index.

The total length of the bone was measured from the superior end of the greater tubercle to the inferior most aspect of the medial epicondyle of the humerus by using an osteometric board. The location of the nutrient foramen was noted with respect to the surfaces. The size of the nutrient foramen was determined by using hypodermic needles of various sizes, which ranged from 18 Gauge to 26 Gauge, of known diameters (18 Gauge =1.2 mm, 20 Gauge = 0.9mm, 24Gauge = 0.55mm and 26 Gauge = 0.45mm). When more than one foramen was found, the larger nutrient foramen was considered as the dominant foramen and its size was measured. All the data were noted and the statistical analysis was done by calculating the percentage, mean, median and the standard deviation.

Foramen Index was calculated using the following formula:

FI = (DNF/TL) x 100 (Hughes[2], Shulman[3]).

FI = Foramen Index, DNF = the distance from the proximal end of the bone to the nutrient foramen, TL = total bone length.

Fig. 1: Showing three nutrient foramina.

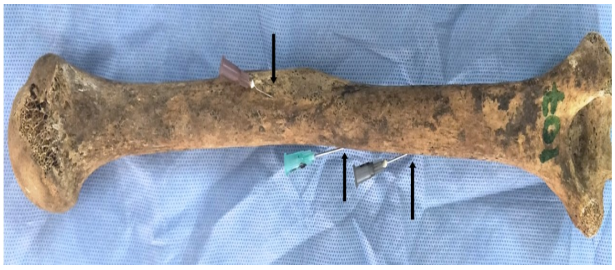
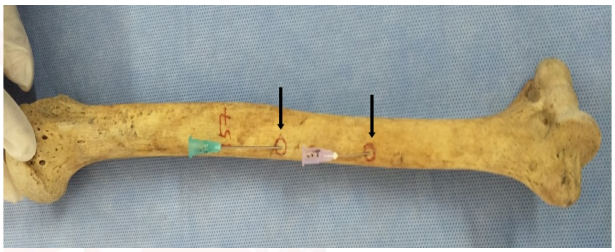


Fig. 2: Showing two nutrient foramina.



RESULTS

Among 218 bones studied, 108 were right sidedand 110 were left sided.The number of nutrient foramina, its size, location in relation to borders and surfaces, and segmental position, are shown in the table number 1,2,3,4 respectively. The length of the bone, distance of the nutrient foramina from the upper end of the bone and foramen index are shown in the table number 5.

Table 1: Showing the Number of the nutrient foramina.

No.of nutrient foramen	Right		Left		Both	
	Number	Percentage	Number	Percentage	Number	Percentage
1	87	80.56%	82	74.55%	169	81.19%
2	16	14.85%	24	21.82%	40	18.35%
3	1	0.92%	0	0	1	0.45%
Absent	4	3.70%	4	3.64%	8	3.67%

Table 2: Showing the Size of the Nutrient Foramina.

Size of the foramen	Right	Percentage	Left	Percentage
1.2 mm	27	22.13%	49	38.30%
0.9 mm	26	21.31%	32	25%
0.55 mm	28	22.95%	21	16.40%
0.45 mm	38	31.14%	26	20.31%

Table 3: Showing Location of nutrient foramina in relation to the borders and surfaces of humerus bone.

Location of nutrient foramina	Right		Left		Both	
	Number	Percentage	Number	percentage	Number	percentage
Anteromedial surface	92	75.40%	88	67.70%	180	82.20%
Medial border	11	9%	20	15.40%	31	14.22%
Anterolateral surface	8	6.60%	14	10.80%	22	9.67%
Anteriorborder	0	0%	2	1.50%	2	0.46%
Posterior surface	11	9%	6	4.60%	17	7.80%
Lateral border	0	0	0	0	0	0

Table 4: Showing the segmental distribution of Nutrient foramina.

N = number of bones

Right humerus (N=108)	Total number of nutrient foramina(104)		Left humerus (N=110)	Total number of nutrient foramina(106)	
	Number	Percentage		Number	Percentage
Upper 1/3rd	0		Upper 1/3rd	0	
Middle1/3rd	97	93.26%	Middle1/3rd	99	93.39
Lower1/3rd	7	6.73%	Lower1/3rd	7	6.60%

Table 5: Showing the Length of the bone, Distance of the nutrient foramina from the Upper end of bone and foramen index.

	Total Length of Bone in cm		Distance from Upper end to NF in cm		FORAMEN INDEX	
	Median	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD
RIGHT	30.5	30.45±2.11	17	17.15±2.6	57.6	56.35±7.36
LEFT	30.5	30.13±2.37	17	16.73±2.54	56.33	55.57±8.5

NF = Nutrient foramina. cm = centimetre. SD = Standard deviation

Table 6: Showing the incidence of number of nutrient foramina by various authors.

Author	S. E. Carrol [7]	Manjunath et al [11]	Hamang Joshi et al [8]	P.G. Laing [6]	Shanta Chandrasekaran et al [12]	Mansur DI et al [10]	Asha rani et al [9]	Present study
No.of humeri studied	71	200	200	30	258	253	120	218
Single NF	48(68%)	161(80.5%)	126(63%)	28(93%)	198(76.74%)	154(60.87%)	104(87%)	169(81.19%)
Two NF	20(28%)	35(17.5%)	66(33%)	2(7%)	53(20.54%)	73(28.85%)	20(11%)	40(18.35%)
Three NF	03(04%)	4(2%)	08(4%)	-	7(2.71%)	16(6.32%)		1(0.45%)
Zero NF							2(2%)	8(3.67%)

Table 7: showing the zonal distribution of the nutrient foramina by various authors.

	Yaseen S	AsharaniSk [9]	S Chandara sekharan [12]	Mansur DI [10]	Present study
Zone I (FI < 33.33)	-	-	-	0.54%	-
Zone II (FI < 33.34 – 66.66)	89%	87%	86.43%	94.84%	89.91%
Zone III (FI < 66.67 - 100)	11%	2%	13.57%	4.62%	6.42%

FI = Foramen index, Zone 1 = upper 1/3rd, zone 2 = middle 1/3rd zone 3 = lower 1/3rd

Table 8: Showing the location of nutrient foramina in relation to the borders and surfaces of humerus bone.

Surface of humerus	Khan AS [14]	Yaseen S [15]	Asharani s k [9]	S Chandrasekharan et al [12]	KC Bohra [16]	Satish M Patel et al [17]	MansurDI [10]	Present study
AMS	96%	88.50%	43%	89.92%	87.10%	38.60%	88.86%	82.11%
PS	2.67%	8.53%	3%	8.53%	4.84%	6.80%	6.52%	
ALS	1.33%	3.50%		1.55%			4.62%	9.63%
AB			2%					0.46%
MB			57%			15.50%		14.22%
LB			3%					
AS					6.45%			
PS					1.61%	13.70%		7.80%

AM = anterio medial surface, PS = posterior surface, AL = Anterio lateral surface, AB = Anterior border, MB = Medial border, LB = Lateral border, AS = Anterior surface, PS = Posterior surface.

DISCUSSION

Humerus is the largest bone of the upper limb. Nutrientartery to this bone usually arises from the profunda brachii artery or as a direct branch from brachial artery [4, 5]. The nutrient artery enters the bone through nutrient foramen located on anteromedial surface, close to the medial border, a little belowits midpoint which is directed downwards [5]. The Knowledge of nutrient foramina is of much importance in various bone reduction and grafting techniques. Laing and Carrol S E opined that avoiding injury to the nutrient artery of the hu-merus is crucial during surgical procedures, for effective fracture healing [6, 7].

As reported by the various authors,single nutrient foramina was observed in almost 80 percent of bones including in the present study, but P G Laing [6] reported the same in 93% of humerii,where asHamang Joshi, et al [8] observed single nutrient foramina in only 63% of bones. Asharani, et al [9] reported the absence of nutrient foramina in 2% of bones, in correspondence with the present study of 3.67%. Mansur DI [10] et al observed 3 nutrient foramina in 6.32% of humerus bones, while the present study showed only 0.45%. The comparative incidence of nutrient foramina is shown in the Table No. 6

Chandrasekaran, et al [12] observed the mean length of the humeriias 27.96 ± 2.18 cm. KS Solanke, et al [13] reported the mean length of right humerii as 28.53 ±1.78cms and left humerii as 28.89 ±1.75cms. Mansur D I, et al [10] in a study of 253 adult humerii noted that the mean length of right sided humerii as 27.05 cm and of left sided humerii as 26.99 cm, with foramen index of 55.18. In the present study the mean length and standard deviation of right and left humerii are slightly higher as compared to the other authors, i.e. 30.45 ±2.11 cm and 30.13 ±2.37 cm respectively.

With respect to the zonal distribution of nutrient foramina and the formamen index the present study corresponds with the other studies indicating the presence of foramina in the middle third of bone. Mansur D I, et al [10] observed the foramina in zone 1, i.e in the upper one third in 0.54% of bones, which is represented in the Table no. 7

Most of the authors reported the presence of the nutrient foramina on the anterio medial surface. Whereas Asharani S K, Satish M Patel, et al observed that only 43% and 38.6% respectively, showed the location of foramina on theanterio medial surface while 57% and 15.5% of the foramina were observed on the medial border respectively. Present study showed 82.11 % of nutrient foramina on the anterio medial surface and 14.22% on the medial border, as represented in the Table No. 8

CONCLUSION

The knowledge of nutrient foramina is of much importance in various bone reduction and grafting techniques in fracture cases like road traffic and industrial accidents, sports injuries and pathological fractures etc. The present study adds to the existing data on nutrient foramina especially in the population of Telangana region.

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Conflicts of Interests: **None**

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