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A Study to Assess Nutrient Foramen of Humerus in Dried Human Bones

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ABSTRACT

Humerus, the long bone of the arm is commonly involved in accidents and injuries. Nutrient foramen is the significant structure, providing the life line in the form of blood vessels which are important for healing of fractures and other assaults. The present study was conducted on 302 dried and cleaned humerus bones of the right and left sides, present in the Department of Anatomy of MGM Medical College, Indore (M.P).The gender and age of the bones was not known. The number of nutrient foramina, their distribution over the surface and borders of humerus and their zone with respect to the three segments of humerus was studied. Bones which were damaged and having pathology were excluded from the study. After excluding the broken bones and the ones in which nutrient foramen could not be identified, 302 bones consisting of a total of 346 foramen were the part of the present study. The mean total length of humeri was 30.56 cm. Majority of humeri had a single nutrient foramen (76.82%). They were absent in 5.96% of bones. 58.09% of the bones had the nutrient foramen on the anteromedial surface with 25.43% bones having the nutrient foramen on the anteromedial border. This was followed by the posterior surface and then the anterolateral surface respectively. Maximum nutrient foramen were present in the II zone i.e middle zone of the bone. One bone had its nutrient foramen in the proximal one third segments. All foramen were directed downwards. Nutrient foramen is variable in its number and location, but functionally it is an extremely significant structure, influencing the nutrition and healing of the injuries, fractures and surgical interventions. Anatomical description of these foramen is hence of great assistance to treating physicians, orthopedic surgeons and in microvascular bone transplants.

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Key Words

Anteromedial surface, bone shaft, humerus, nutrient canal, nutrient foramen

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INTRODUCTION

There is presence of nutrient canal in the shaft of long bones which extends from an opening mostly on the surface called nutrient foramen and traverses via cortex of the bone till the medullary cavity. In the humerus also an oblique nutrient canal is present through which nutrient artery runs and provides a profuse blood supply to the inner 2/3rd of the cortex and to the medullary cavity[1].

Blood supply of nutrient artery of humerus is very crucial as its medullary arterial network is essential for reformation of the vessels of the necrotizing cortex and the union of callus at rupture spots in fracture healing. A fractured bone segment may fail to unite or union may be delayed if blood supply to the site is disrupted due to damaged nutrient artery[2]. Fracture of shaft of humerus account for nearly 3% of total fractures[3,4]. Injury to the nutrient artery of the humerus can have several potential effects, depending on the severity of the injury and the extent of damage to the blood supply. These can be impaired bone healing, avascular necrosis, increased risk of infection, impaired growth in children and complications in surgery[5,6]. Orthopedic and trauma surgeon have to be very cautious while handling nutrient artery which can prevent chances of delayed union or nonunion to a great extent. In some cases, surgical repair or revascularization procedures may be necessary to restore blood flow to the affected area and minimize the long-term consequences of the injury[7].

This requires a precise knowledge of location, number and related anatomical aspects of nutrient foramen[8]. So, in our study, we systematically observed the anatomical features of nutrient foramina in humeral diaphysis

MATERIALS AND METHODS

Ethics committee of MGM Medical College approved the study protocol. Present study consisted of 302 dried and cleaned humerus bones inclusive of both right and left sides present in department of Anatomy MGM Medical College, Indore (M.P.). Bones which were damaged and those which were having pathological abnormalities were excluded from the study. The side of the bone was identified. Then the position of nutrient foramen was observed carefully. The nutrient foramina were distinguished by the presence of a well-marked groove leading to the foramen and by a well-marked often slightly raised edge of the foramen at the commencement of the canal. Location of nutrient foramen in relation with surface and zone were observed and recorded. Also we have noted the presence of nutrient foramen on the border separately. Direction of nutrient foramen in relation with growing end of humerus was noted.

Determination of total length of the individual humerus was done with the help of Osteometric board as the distance between the superior aspect of the head and the most distal aspect of the trochlea of each humerus in millimeter. Then the whole length of the humerus was divided into 3 equal parts viz Upper1/3rd as Zone-1, middle 1/3rd as Zone-2 and lower 1/3rd as Zone-3 from proximal to distal end. Location of nutrient foramen with respect to surface and zone was determined and recorded.

RESULTS AND DISCUSSIONS

A total of 302 humerus bones including both right (n = 146-48.3%) and left (n = 156 = 51.7%) consisting of altogether 346 nutrient foramina were studied. In the present study mean total length of humerus was found to be 30.56 cm with right humerus showing mean total length of 30.14 cm and of left humerus showing mean of 30.398 cm. Also mean distance from most proximal aspect of humerus to nutrient foramen is 17.06 cm in right humerus and 17.22 cm in left humerus. Number of nutrient foramens in humerus bone is shown in Table 1. Distribution of nutrient foramen over the surface and borders of humerus bone is shown in Table 2. Also, the presence of foramen with respect to three segment of the bone is shown in Table 3.

Table 1: Number of nutrient foramens in humerus bone

	Right (n = 146)		Left (n = 156)		Total (n = 302)	
No. of nutrient foramen	No. of humerus	%	No. of humerus	%	No. of humerus	%
0	8	5.4	10	6.41	18	5.96
1	116	79.4	116	74.35	232	76.82
2	19	13.0	23	14.74	42	13.9
3	3	2.05	7	4.48	10	3.31
Total	146		156		302	

Table 2: Distribution of nutrient foramen over the surface and borders of humerus bone

	Right humerus		Left humerus		Total	
Surfaces/Border	No. of NF	%	No. of NF	%	No. of NF	%
AMS	104	63.8	97	53.01	201	58.09
PS	20	12.27	24	13.11	44	12.72
AMB	33	20.25	55	30.05	88	25.43
ALS	4	2.45	4	2.19	8	2.31
AB	2	1.23	3	1.64	5	1.45
Total	163	100	183	100	346	100

NF: Nutrient foramen

Table 3: Presence of foramen with respect to three segment of the bone

	Right humerus		Left humerus		Total	
Zones	No. of NF	%	No. of NF	%	No. of NF	%
Zone I	01	0.61	01	0.54	02	0.57
Zone II	155	95.09	170	92.89	325	93.93
Zone III	7	4.29	12	6.56	19	5.49
Total	163		183		346	

Table 4: Comparison of present study with other similar studies

	Nutrient foramen (n-no. of nutrient foramen)			Zone of nutrient foramen			Location (Surface/Border) of nutrient foramen		
Studies/Author		No.	Percentage		No.	Percentage		No.	Percentage
Present study (2023) (N = 302)	n = 0	18	5.96	1	02	0.57	AMS	201	58.09
	n = 1	232	76.82	2	325	93.93	PS	44	12.72
	n = 2	42	13.9	3	19	5.49	AMB	88	25.43
	n = 3	10	3.31				ALS	8	2.31
	n = 4	0	0				AB	5	1.45
Kumar *et al*.[10] (N = 80)	0	3	3.75	1		-	AMS	73	89.02
	1	73	91.25	2		86.58	PS	1	1.22
	2	3	3.75	3		13.42	ALS	8	9.76
	3	1	1.25						
Haris *et al*.[9] (N = 50)	1	33	66	1	2	4	AMS	40	80
	2	14	28	2	42	84	ALS	4	8
	3	3	6	3	6	12	PS	6	12
Mansur *et al*.[8] (N = 253)	n = 0	5	1.98	1	2	0.54	AMS	327	88.86
	n = 1	154	60.87	2	349	94.84	PS	24	6.52
	n = 2	73	28.85	3	17	4.62	ALS	17	4.62
	n = 3	16	6.32						
	n = 4	5	1.98						
Chandrasekaran[11] (N = 258)	1	198	76.74	1	0	0	AMS	232	89.92
	2	53	20.54	2	223	86.43	ALS	4	1.55
	3	7	2.71	3	35	13.57	PS	22	8.53

We also studied and noted the direction of nutrient foramen in all humerus bone. All the nutrient foramen were directed towards the lower end of humerus bone.

Blood supply is the prime factor which promotes healing of fractures and damage to nutrient artery causes significant effect on various surgical outcomes[1-2]. Therefore present study was conducted to delineate important anatomical parameters of nutrient foramen and relative variations with respect to humerus bone. We conducted study on 302 humerus bone consisting of 146 right and 156 left humerus bone.

Number of Nutrient Foramina: Single nutrient foramen was observed in 76.8% (n-232) of humerus bone with 79.4% (n-116) of right humerus and 74.3% (n-116) of left humerus. Our findings are intermediate with findings greater than Mansur *et al*.[8] having 60.87% and Haris *et al*.[9] having 66%. Our findings are equal to Chandrasekaran[11] having 76.74% and lesser than Kumar *et al*.[10] having 91.25%.

Double nutrient foramen is also seen in significant number of humerus being present in 13.9% of total bones. Our finding was less than Mansur *et al*.[8] who found double nutrient foramen in 28.85% of dried humerus bones. Similarly findings of Haris *et al*.[9], who found two nutrient foramens in 28% of humerus bones was more than that found in this study. On the other hand. Kumar *et al*.[10] found two nutrient foramen in just 3.75% bones. Chandrasekaran[11] found double nutrient foramens in 20.54% of bones.

Triple nutrient foramen was seen in total 10 humerus bone contributing to 3.31%. Our findings are comparatively very less compared to Mansur *et al*.[8] having 6.32% and Haris *et al*.[9] having 6%. Though Kumar *et al*.[10] found only 1.25% and Chandrasekaran[11] found 2.71% of triple nutrient foramen in humerus bone.

Quadruple number were not seen in any humerus bone in our study while Mansur *et al*.[8] have found 1.98% of four nutrient foramen containing humerus bone.

Present study showed 5.96% of humerus having no nutrient foramen consisting of 5.4% in right side and 6.41% in left side. Our study indicates comparatively higher incidence than the study conducted by Mansur *et al*.[8] having 1.98% and Kumar *et al*.[10] having 3.75%.

Direction of nutrient foramen were constant in each and every humerus bone and obeys the law of ossification. It is similar to findings of Bhatnagar *et al*.[12] and Yaseen *et al*.[13].

Zone of Nutrient Foramen: Zonal distribution of nutrient foramen was found to be located in Zone-2 in 93.93% of humerus in our study. Our results were correlated with the other authors[8-11] studies as well with 94.84% in Mansur *et al*.[8], 86.58% in Kumar *et al*.[10], 86.43% in Chandrasekaran[11] and 84% in Haris *et al*.[9] study (Table 4).

Location of Nutrient Foramen: Anatomy of location of nutrient foramen is very significant for surgeons while dealing with humerus pathologies. In our study we

found nutrient foramen present in Anteromedial surface, Posterior surface, Anterolateral surface, Anteromedial border and Anterior border of humerus. Anteromedial surface (AMS) was found to be the most common position for humeral foramen in our and other authors[8-11] studies. It was found in 58.09% of humerus in our study while 89.92% in Chandrasekaran[11], 89.02% in Kumar *et al*.[10], 88% in Mansur *et al*.[8] and 80% in Haris *et al*.[9] studies which was significantly higher than our study. 25.43% of nutrient foramen in our study was found on anteromedial border (AMB) which was specifically indicated in our study combining this with the AMS 83.52% results can be correlated and came near with other studies as well (Table 4).

Posterior surface (PS) the next common position for humeral nutrient foramen with 12.72% in our study, 12% in Haris *et al*.[9], 8.53% in Chandrasekaran[11] and 6.52% in Mansur *et al*.[8] with the exception of 1.22% in Kumar *et al*.[10] study. In Kumar *et al*.[10] study anterolateral surface (9.76%) was more common position than posterior surface (1.22%).

Anterolateral surface (ALS) and Anterior border (AB) were least preferred humeral nutrient foramen position in all studies including ours (Table 4).

CONCLUSION

The variations in length and distances observed highlight the inherent anatomical variability in the humerus bones, emphasizing the importance of individualized approaches in clinical practice. The mean distance from the most proximal aspect of the humerus to the nutrient foramen is similar in both right and left humerus bones, with 17.06 cm for the right and 17.22 cm for the left. The majority of the humeri had one nutrient foramen. This indicates that a significant portion of the sample has a single point of entry for nutrient vessels. The highest number of nutrient foramina (201 out of 346) is observed in the Antero medial surface (AMS). This suggests that a significant majority of humeri have a concentration of nutrient foramina in this particular segment. This information is valuable for understanding the anatomical distribution of nutrient vessels in the antero-medial aspects of the humeri. The segment-specific distribution of nutrient foramina highlights the need for a detailed understanding of the anatomy of each segment of the humerus. This can contribute to more precise diagnoses and treatment strategies in clinical practice.

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