

A Morphometric study of nutrient foramen in dry adult human humerus bone.

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Abstract:

Background: Humerus is the bone of the arm & the longest bone of the upper limb. The main source of nutrition to long bone during growth & ossification is nutrient artery which passes through the nutrient foramen. The anatomical knowledge of these foramina is useful in certain operative procedures to preserve the circulation.

Methodology: The study was conducted on 100 dry adult human Humerus of both sides of unknown sex, collected from department of Anatomy, Mysore medical college & research institute, Mysuru, Karnataka. Total humerus length along with the location, number, and direction of all the nutrient foramen present were recorded. The bones were photographed & data obtained was tabulated, results noted and the inference was drawn.

Result: The nutrient foramina were observed in all 100 Humerus, single nutrient foramen in 72 (Rt-37 & Lt-35) bones, double nutrient foramen in 24 (Rt-10 & Lt-14) bones, Triple nutrient foramen 01 (Rt) and Absent nutrient foramen – 03 (Rt-02 & Lt-01) The most common location of nutrient foramen was present on anteromedial surface, near its middle.

Conclusion: The anatomical knowledge of nutrient foramen is important for orthopaedic Surgeons during surgical procedures such as fracture repair, bone reduction, external & internal fixation device & bone grafting.

Key words: Humerus, Nutrient foramen, Nutrient artery, Foraminal Index, Bone graft.

1. Introduction

Humerus is the bone of the arm & the longest bone of the upper limb. The main source of nutrition to any long bone during growth & ossification is nutrient artery which passes through the nutrient foramen. Lack of an adequate vascular supply can significantly delay or prevent fracture healing. Nutrient artery is the major source of blood supply to the long bone and hence plays an important role in fracture healing. Nutrient artery to this bone usually arises from the profunda brachii artery or as a direct branch from brachial artery. The nutrient artery enters the bone through nutrient foramen located on anteromedial

surface, close to the medial border, a little below its midpoint which is directed downwards ^[1]. Thus, Anatomical knowledge of these nutrient foramina is useful in certain operative procedures (bone reduction and grafting techniques) to preserve the circulation.

2. Objectives

The study was conducted to know the following parameters of nutrient foramen of Humerus:

- Number, Position, Location, Direction
- Distance of nutrient foramen from upper end of Humerus.

Materials and Methods

Study setting: Department of Anatomy, MMC & RI, Mysore.

Study design: Descriptive study.

Study period: over 1 year.

Sample size: 100 Adult dry human Humerus bone (right 50 & left 50) of unknown sex.

Inclusion criteria: Fully ossified adult Humerus bone was included.

Exclusion criteria: Damaged, mutilated, deformed Humerus bone was excluded.

3. Observations and Results

100 humerus bones were studied, (50 Rt & 50 Lt) sided bones of unknown sex.

The number of Nutrient foramens, Location, Segmental position are studied.

The Foramen Index was calculated by using the following formula:

$$FI = \text{DNF} / \text{TL} \times 100 \text{ (Hughes)}$$

Humerus bone showing the number of Nutrient foramina.

Fig:1. Humerus bones (100) used for the study.



Fig: 2. Osteometric board to measure length of Humerus bone.



No of Nutrient foramen	Right Humerus (50)		Left Humerus (50)		Total (100)	
	Number	%	Number	%	Number	%
1	37	74	35	70	72	72
2	10	20	14	28	24	24
3	1	02	00	00	01	01
Absent	2	04	01	02	03	03
Total	60		63		123	

Table: 1. Humerus showing the number of nutrient foramens.

Fig: 3. Humerus bone showing single nutrient foramen.



Fig: 4. Humerus bone showing double nutrient foramen.



Fig: 5. Humerus showing triple nutrient foramen.



Fig: 6. Nutrient foramen in Anteromedial surface of Humerus bone.



Fig: 7. Nutrient foramen in Anterolateral surface of Humerus bone.



Fig: 8. Nutrient foramen in Posterior surface of Humerus bone.



Fig: 9. Nutrient foramen in Medial border of Humerus bone.



Fig: 10. Blood supply of a long bone.

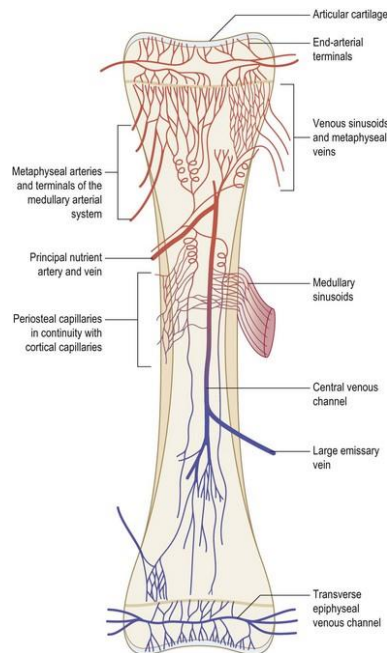


Table: 2. Nutrient foramen present in relation to the surfaces & borders of Humerus bone.

Location	Right Humerus (60)		Left Humerus (63)		Total (123)	
	Number	%	Number	%	Number	%
Antero-medial surface	45	75	41	65.07	86	69.91
Medial border	6	10	10	15.87	16	13
Antero-lateral surface	3	05	5	7.93	08	6.5
Anterior border	0	00	3	4.76	03	2.43
Posterior surface	6	10	4	6.34	10	8.13
Lateral border	0	00	0	00	00	00

Table: 3. Segmental distribution (Position) of nutrient foramen.

Rt- Humerus (50)	Total number of nutrient foramen (60)		Lt-Humerus (50)	Total number of nutrient foramen (63)	
	Number	%		Number	%
Upper 1/3	0		Upper 1/3	0	
Middle 1/3	54	90	Middle 1/3	56	88.88
Lower 1/3	06	10	Lower 1/3	07	11.11

Table: 4. Foraminal Index (FI)= DNF / TL X 100 (Hughes) of present study.

Parameters	Right (50)	Left (50)	Total (100)
Mean total length	301.04 mm	290.6 mm	292.5 mm
Distance from upper end to NF	152.62mm	155.66 mm	158.24 mm
Foraminal Index	50.28%	52.89%	51.55%

4. Discussion

One or two main diaphysial nutrient arteries enter the shaft obliquely through nutrient foramina, which lead into nutrient canals. Their sites of entry and angulation are almost constant and characteristically directed away from the dominant growing epiphysis. Nutrient arteries do not branch in their canals but divide into ascending and descending branches in the medullary cavity; these approach the epiphyses, dividing repeatedly into smaller helical branches close to the endosteal surface. The endosteal vessels are vulnerable during surgical operations, such as intramedullary nailing, which involve passing metal implants into the medullary canal. The long bone is supplied by four sets of arteries – Diaphysial nutrient A, Metaphysial A, Epiphysial A and Periosteal A^[1].

As reported by the various authors, single nutrient foramina were observed in almost 80 percent of bones including in the present study, but Laing PG^[2] reported the same in 93% of humerus, whereas Hamang Joshi et al^[3] observed single nutrient foramina in only 63% of bones, while the present study showed 72 %. Asharani, et al^[4] reported the absence of nutrient foramina in 2% of bones, in correspondence with the present study of 3 %. Mansur et al^[5] observed 3 nutrient foramina in 6.32% of humerus bones, while the present study showed only 1%.

Khan (96 %) ^[6], Chandrashekar (89.92 %) ^[7], Mansur (88.86 %) in their study observed nutrient foramen in anteromedial surface, which is much higher when compared to present study showing (69.91%). The nutrient foramen was present in posterior surface of humerus bone in the following authors – Yaseen^[8] (8.53 %), Chandrashekar (8.53%) and Present study (8.13%).

The range of Foramen Index was much lower in the study done by Mysorekar^[9] & Kiezilakanat, when compared to present study and almost same with the study done by Pereira & Bhojara VS^[10].

Table: 5. Comparison of Number of nutrient foramens by various authors.

Author	Humerus (n)	Single NF	Two NF	Three NF	Zero NF
Carrol SE et al ^[11]	71	48 (68%)	20(28%)	03(08%)	
Manjunath SH et al ^[12]	200	161 (80.5%)	35(17.5%)	4(2%)	
Hamang Joshi et al ^[3]	200	126 (63%)	66(33%)	08(4%)	
PG Laing ^[2]	30	28 (93%)	02(7%)	-	
Chandrashekar S et al ^[7]	258	198 (76.74)	53(20.54%)	7(2.71%)	
Mansur DI et al ^[5]	253	154(60.87%)	73(28.85%)	16(6.32%)	
Asharani SK et al ^[4]	120	104 (87%)	20(11%)		2(2%)
Present study	100	72 (72%)	24 (24%)	01 (01%)	03

Table: 6. Comparison of Location of nutrient foramen by various authors.

Authors	Humerus bone – Border and Surface					
	AMS	PS	ALS	AB	MB	LB
Khan AS et al ^[6]	96 %	2.67 %	1.33 %			
Yaseen et al	88.50 %	8.53 %	3.50 %			
Asharani SK et al	43 %	03 %	-	02 %	57 %	03 %
Chandrashekara n S et al	89.92 %	8.53 %	1.55 %			
Mansur DI et al	88.86 %	6.52 %	4.62 %			
Present study	69.91 %	8.13 %	6.50 %	2.43%	13.0%	

Table: 7. Comparison of Foramen Index of nutrient foramen by various authors.

Authors	Study population	Number of Bones studied	Mean length (cm) of Humerus bone	Foramen Index (range). FI = DNF / TL X100
Carroll SE-1963	East Indian & NA	71	29.4	-

Mysorekar VR-1967	Indian	180	-	26.51 – 74.46
Forriol Campos 1987	Spanish	36	-	47.10 – 63.70
Kizilkanat E ^[13] , 2007	Turkish	101	30.64	15.00- 69.40
Pereira 2011	Southern Brazil	174	-	32.1 – 68.8
BhojarajaVS, et al 2014	Indian	100	30.7	41.11 – 66.86
Present study	Indian	100	29.95	39.34 – 81.02

5. Conclusion

It is evident from the study that majority of the humerus bones have single nutrient foramen and they are mainly located on the anteromedial surface specially in the middle 1/3rd and the direction of nutrient foramina was towards the elbow. Middle 1/3rd of anteromedial surface is more vulnerable to surgical or traumatic injuries that may damage nutrient artery, thus highlights its significance. The knowledge about location and number of nutrient foramina is important for Orthopaedic Surgeons during surgical procedures such as fracture repair, bone grafts and microsurgeries.

6. Acknowledgment.

I thank Teaching & Non-teaching staff, department of Anatomy, MMC & RI, Mysuru for their support. I thank one & all.

Conflict of Interest: None.



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