

“A Study on Diaphyseal Nutrient Foramina of Dry Human Tibia Bones In Rayalaseema Region”

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Abstract: Aim of Study : The main aim of the study is to know the variations in number, directions, the locations and position of the nutrient foramina in the Tibia. Place of Study: This study was done in the Departments of Anatomy and Forensic Medicine, S.V. Medical College, Tirupati, A.P., during the month of April and May of 2018. Material and methods: The study was done on 108 Tibia in which 52 were of right sided and 56 were of left sided. Every bone was carefully observed for the variations of nutrient foramina, about their numbers, position and directions. All the findings were observed and noted in the tabular form and are compared with available literatures. RESULTS: Out of 108 tibia bones, 52 were right sided and 56 were left sided in which 95 tibia showed single nutrient foramina (87.9%) and 11 tibia showed double nutrient foramina (10.18%) and 2 tibia showed no nutrient foramina (1.85%). 3 nutrient foramina were seen on the soleal line and all the remaining nutrient foramina were observed below the soleal line in the upper third of posterior surface of the tibia.

Key Words: Nutrient artery, Foramen, Tibia, Direction, Location.

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I. Introduction

Nutrient foramina are the openings for the blood vessels. One or two main diaphyseal 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 which approach the epiphyses, dividing repeatedly into smaller helical branches close to the endosteal surface. The endosteal vessels are vulnerable during operations which involve passing metal implants into the medullary canal, e.g. intramedullary nailing for fractures. Near the epiphyses they are joined by terminal branches of numerous metaphyseal and epiphyseal arteries. The epiphyseal and metaphyseal arterial supply is richer than the diaphyseal supply¹. Nutrient artery grows in the periosteal bud and before piercing the bone, artery presents a tortuosity which minimizes the blood pressure and allows movement of bone without affecting the nutrient vessel².

The nutrient foramen is directed away from the growing end of the bone; their directions are indicated by a jingle, “To the elbow I go, from the knee I flee”³.

The nutrient foramen in tibia usually lies near the soleal line and transmits a branch of the posterior tibial artery; the nutrient vessel may also arise at the level of the popliteal bifurcation or as a branch from the anterior tibial artery¹.

II. Materials And Methods

The study was done in the departments of Anatomy and Forensic Medicine in S.V. Medical College, Tirupati, A.P., during the month of April and May of 2018. A total of 108 dry human tibia of unknown age and sex were collected from both the departments and observed for number, direction, position of nutrient foramina were tabulated and the length of tibia and length of nutrient foramina were noted with the use of Osteometric board. Foramina index (FI)⁴ was calculated by : distance of nutrient foramina from the upper end / total length of the bone × 100 .

III. Observations And Results

In the present study, out of 108 tibia bones, 52 were right sided and 56 were left sided in which 95 tibia showed single nutrient foramina (87.96%) and 11 tibia showed double nutrient foramina (10.18%) and 2 tibia showed no nutrient foramina (1.85%). Among the right sided tibia, foramen index was 30.6 ± 4.71 cms in which 35 tibia showed nutrient foramen in the upper one third and 17 tibia showed nutrient foramina in the middle

one-third and among the left sided tibia foramen index was 30.94 ± 3.49 cms, in which 37 tibia showed nutrient foramina in the upper one third and 19 tibia showed nutrient foramina in the middle one third. 3 nutrient foramina were seen on the soleal line and remaining all the nutrient foramina were observed below the soleal line in the upper third of posterior surface of the tibia and and no tibia showed nutrient foramina neither in the medial or lateral surfaces nor in the middle and lower thirds of the tibia. Maximum length of the tibia was 44.2 cms and the minimum length of the tibia was 31.5cms. Minimum distance of nutrient foramina from the upper end was 7.5 cms and the maximum distance of nutrient foramina from the upper end was 15.5cms.

TABLE NO.1: SHOWING LENGTH (L), NUMBER (n) & DISTANCE OF NUTIENT FORAMINA (D) & FORAMEN INDEX (F.I) ON RIGHT SIDED BONES:

SL.NO	L	D	F.I	n
1	36.5	10.2	27.9	1
2	42.2	10.5	24.8	1
3	41	11	26.8	1
4	42.5	11.5	27.05	1
5	40	11.6	29	1
6	35.7	13	36.41	1
7	36.8	10.5	28.5	1
8	37.6	12.5	33.02	1
9	36.4	11	30.02	1
10	33.5	13	38.8	1
11	41.4	12.5	30.1	2
12	40.5	12	29.6	1
13	34.6	11.6	33.5	1
14	42.3	11.7	27.6	1
15	41.6	11	26.4	1
16	41.5	12	28.9	1
17	44.2	10.5	23.75	1
18	37.8	11.3	29.8	2
19	36.5	13.3	36.4	1
20	35.7	10.5	29.4	1
21	36.8	7.5	20.3	2
22	34.8	14.4	41.3	1
23	41.2	15.5	37.6	0
24	38.7	14.4	37.2	1
25	37	12.5	33.78	1
26	38.5	13.5	35.06	1
27	33.4	12	35.9	1
SL.NO	L	D	F.I	n
28	36.7	13	35.4	1
29	38	9.5	25	1
30	42	12.7	30.23	1
31	41.5	13.8	33.25	1
32	43	14	32.5	1
33	40	12	30	1
34	37.6	10.5	27.9	1
35	36.5	12	32.8	1
36	33	10.5	31.8	2
37	34.8	9.8	28.1	1
38	34.5	11.6	33.6	1
39	31.5	12.5	39.6	1
40	36.4	10.5	28.8	1
41	38	14.4	37.8	1
42	34.6	13.5	39.01	1
43	44.2	13	29.41	1
44	43.2	9.6	22.2	1
45	36.5	10.5	28.7	2
46	34.2	12.6	36.8	1
47	41.5	13	31.32	1
48	37.5	12.3	32.8	1
49	38	13	34.2	1
50	42.5	11	25.8	1
51	34.5	10	28.9	1
52	43	11.5	26.7	1

TABLE NO.2: SHOWING LENGTH (L), NUMBER (n) & DISTANCE (D) OF NUTIENT FORAMINA & FORAMEN INDEX (F.I) ON LEFT SIDED BONES :

SL.NO	L	D	F.I	n
1	34.5	11	31.8	1
2	35.7	10.5	29.4	1
3	36.3	11	30.3	1
4	38.4	11.6	30.2	1
5	39.6	13	32.82	1
6	37	12	32.43	1
7	41.5	13.4	32.28	1
8	35.3	12.4	35.12	1
9	43	11.7	27.2	2
10	36.5	12	32.87	1
11	39.2	11	28.06	1
12	37.5	9.5	25.33	1
13	41.5	13.3	32.04	1
14	38.5	11	28.57	1
15	36.4	10.5	28.8	1
16	38.7	11.6	29.9	1
17	38.4	13.2	34.37	1
18	37.2	10.8	29.03	1
19	36.5	11	30.13	1
20	35.3	12.4	35.12	1
21	38.7	13.2	34.1	2
22	34.5	9.8	28.4	1
23	33.6	12.3	36.6	1
24	37.2	9.5	25.5	1
25	38.9	12	30.8	1
26	36.8	11	29.8	1
27	36.4	13	35.71	1
28	37.6	13.6	36.17	1
SL.NO	L	D	F.I	n
29	38.2	11.5	30.1	2
30	38.7	12.7	32.8	1
31	38	10.8	28.42	1
32	39.8	12	30.15	0
33	36.5	13	35.61	2
34	38.7	11.4	29.45	1
35	34.4	11	31.9	1
36	35.6	12.4	34.8	1
37	31.2	8.5	27.2	2
38	37.5	10	26.66	1
39	33.4	12	35.9	1
40	32.8	13.2	40.24	1
41	36.4	11	30.21	1
42	42.7	12.5	29.27	1
43	35.6	13	36.5	1
44	32	12.6	39.37	1
45	33.2	11.7	35.24	1
46	34.2	12	35.02	2
47	34.3	10	29.15	1
48	35.6	10.5	29.49	1
49	36.4	13	35.71	1
50	32.7	11	33.6	1
51	37.8	13	34.39	1
52	36.7	9.5	25.8	1
53	36.5	11	30.13	1
54	34	11.6	34.11	1
55	37	10	27.02	1
56	38.6	12	31.08	1

TABLE NO.3: SHOWING STATISTICAL VALUES ON LENGTH OF THE BONE, DISTANCE OF THE NUTRIENT FORAMINA FROM THE UPPER END AND FORAMEN INDEX:

SIDE	TOTAL LENGTH OF THE BONE		DISTANCE OF NF FROM UPPER END		FORAMEN INDEX	
	Mean in cm	Median \pm SD in cm	Mean in cm	Median \pm SD in cm	Mean	Median \pm SD
RIGHT (n = 52)	38.30	37.7 \pm 3.31	11.8	12 \pm 1.52	31.18	30.6 \pm 4.71
LEFT (n = 56)	36.77	36.6 \pm 2.51	11.61	11.65 \pm 1.19	31.64	30.94 \pm 3.49

FIGURE NO.1: SHOWING THE NUTRIENT FORAMINA OVER THE SOLEAL LINE



FIGURE NO.2: SHOWING DOUBLE NUTRIENT FORAMINA

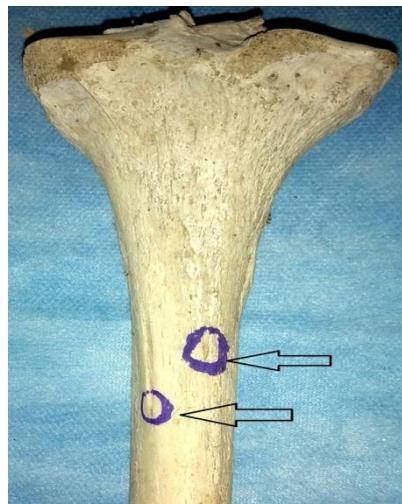


FIGURE NO.3 SHOWING THE MEASUREMENT OF TIBIA ON OSTEOMETRIC BOARD



IV. Discussion

Arun Kumar S. Bilodi⁵ in his study, out of 60 tibia he observed more number of nutrient foramina in the upper one third, only two tibiae showed the presence of nutrient foramina in their middle one third.

P. Mazengenya et.al⁶ also observed double nutrient foramina on one tibia (0.6%) in blacks and on three tibiae (1.7%) in white South Africans. Regarding the location of the nutrient foramina, in black South Africans 75.6% of the tibiae had their nutrient foramina located on the posterior surface, 22.8% on the posterolateral surface and 1.7% on the lateral surface. The situation in white South Africans was 77.8% of the tibia had nutrient foramina located on the posterior surface, 20.6% on the posterolateral surface and 1.7% on the lateral surface. The mean FI of the tibia was 31.66% and 33.15% for both blacks and whites respectively. The majority of the nutrient foramina were found in the upper third, and the remainder in the middle third of the total bone length.

Bichitrnanda Roul⁷ observed 83.7 % of single nutrient foramina and 16.2 % of double nutrient foramina in tibia bones and also found nutrient foramina in upper 1/3rd in 34 cases & in 3 cases it was found in middle 1/3rd and no nutrient foramen was found in lower 1/3rd.

Sharma M et.al⁸ 96% tibiae (48 out of 50) had single nutrient foramen seen on the posterior surface of tibia. Double nutrient foramina were found in remaining 4% tibiae (2 out of 50).

Anusha P et.al⁹ in a study, most of the nutrient foramina in the tibiae were in the proximal third 88%, with the foraminal index ranging between 32.4 and 68.1% of the bone length. Nutrient foramina were located in the middle third in the rest of the tibiae examined (12%). There were no foramina in the distal third.

Swapna A. Ambekar et.al¹⁰ observed 94.3% of tibiae were having single nutrient foramina and 1.9% of tibia were having double nutrient foramina and 3.8% of tibia possess triple nutrient foramina. Tibia with more than 3 nutrient foramina and tibia with no nutrient foramina were not found and majority of nutrient foramina were seen in the upper one third of the tibia.

Udaya Kumar P et.al¹¹ in a study, observed almost all the bones showed nutrient foramina away from the knee but two left sided and three right sided tibia bones defied the growing end theory. The total length of the tibia was observed to be 37.26 ± 2.83 on right side and 37.54 ± 2.30 on left side, with foramen Index of 32.09 ± 3.76 cm on right side, and 32.12 ± 3.13 left side. Nutrient foramina are located predominantly in the upper third of the bone. No foramina were observed in lower third of the bones. On an average 79% of foramina are located below the soleal line. In the present study, only two right sided tibia bones, showed three nutrient foramina. Two nutrient foramina were observed in 13.51% right sided and 10.39% left sided tibia.

Venkatesh Kamath¹² et.al, observed 97.18% of tibia had foramen on the posterior surface and 2.82% on medial surface. 74.65% of the foramina were in the upper third 25.35% were in the middle third. The mean foraminal index in tibia was 32.08. This implies that majority of the primary diaphyseal foramina in the tibia are in the upper third.

Narinder Singh¹³ et.al, observed in all the 70 bones the nutrient foramen was directed downwards. The mean distance of nutrient foramen from the upper end of tibia was compared. On the right side it was 118.23 ± 7.69 mm (Range = 99 -132mm). The corresponding values on left side was 114.34 ± 9.42 mm (Range =100 -130mm). All the bones had a single nutrient foramen. The nutrient foramen is situated in the upper third of the posterior surface of tibia in all. Most of them lie lateral to the vertical line on the posterior surface.

Nutrient artery supplies seventy to eighty percent of blood to long bones during childhood¹⁴. In the case of their absence, the vascularisation occurs through the periosteal vessels¹⁵. In the present study, 87.96% showed single nutrient foramina and 10.18% tibia showed double nutrient foramina and 1.85% tibia showed no nutrient foramina. Among the right sided tibia, foramen index was 30.6 ± 4.71 cms in which 35 tibia showed nutrient foramen in the upper one third and 17 tibia showed nutrient foramina in the middle one-third and among the left side tibia foramen index was 30.94 ± 3.49 cms, in which 37 tibia showed nutrient foramina in the upper one third and 19 tibia showed nutrient foramina in the middle one third. 3 nutrient foramina were seen on the soleal line and remaining all the nutrient foramina were observed below the soleal line in the upper third of posterior

surface of the tibia and and no tibia showed nutrient foramina neither in the medial or lateral surfaces nor in the middle and lower thirds of the tibia.

The present study correlates with the studies of Arun Kumar S. Bilodi⁵, P.Mazengenya et.al⁶, Bichitrananda Roul⁷, Swapna A. Ambekar et.al¹⁰, Udaya Kumar P¹¹, Venkatesh Kamath¹². Agarwal et al¹⁶, Vadhel¹⁷ et.al, Tejaswi¹⁸ et.al, and Kizilkanat¹⁹ et.al, reported that the nutrient foramen is directed away from the knee joint whose studies correlates with the present study. The present study also correlates with Roopam²⁰ et.al, and Prashanth²¹ et.al, reported absence of nutrient foramina in 3.7% and 1.4% of tibia respectively.

V. Conclusion

The present study reveals most of the nutrient foramina were in the upper end and posterior surface of the tibia and all the nutrient foramina are directed away from the growing end i.e., upper end of tibia. The study of Nutrient foramina is of paramount importance in preserving the vasculature of the bone for the orthopaedic surgeons which is essential in healing the fracture ends and bone grafting procedures. It is also essential to keep in mind by the anthropologists estimation of the age. Fracture of tibia or both lower limb bones are common in road traffic accidents. The surgeon should rule out the possibility of blood loss at the fracture site failing which may land in litigation and complication of delayed union of the bone.

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