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A Morphometric Study of Nutrient foramen of Tibia in East Godavari Region

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Abstract

To have a better outcome for the surgical intervention of leg, taking consideration of the details of the nutrient foramen is of prime importance.The nutrient foramen is a canal with proximal groove which allows the nutrient artery to go through the bone and supply the medullary cavity and inner cortex of the bone, here it is the posterior tibial artery. The study was undertaken on 116 dried tibia from G.S.L Medical College Rajahamundry. The detail study of the nutrient foramen of tibia was done accounting its number, size, direction, foramina index and position of foramen with respect to soleal line. In 69 right sided tibia 84% of the cases have the nutrient foramen in the upper third and rest 16% were present in the miidle third of the bone, all directed downwards with 95% of cases directed lateral to soleal line whereas in 47 left sided tibia 85% of the cases it is placed in the upper third keeping rest 15% in the middle third of the tibia all directed downward with 93% of cases directed lateral to soleal line leaving 7% to be upon the soleal line. The present study was found to be in accordance to the previous studies done by various researches and agreed to the the same results as of this one. The knowledge of morphology of Nutrient foramen is applied by orthopaedic surgeons to perform various surgical intervention like fracture repair, bone grafting and bone transplantation.

Keywords: Foramina Index; Nutrient Foramen; Nutrient Artery; Bone Grafting; Bone Transplantation.

Introduction

Nutrient foramen is the foramen which is present on the shaft of long bone responsible for providing nutrition to the bones through the nutrient artery [14]. Nutrient foramen of long bones is observed by their elevated margins & the presence of groove proximal to it [5].

One or two diaphysial nutrient arteries enter the shaft obliquely through the 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 approaches the epiphysis dividing repeatedly into smaller helical branches close to the endosteal surface. The endosteal vessels are vulnerable during surgical operation such as intramedullary nailing, which involve passing metal implants into the medullary canal.

In tibia nutrient foramen lies near the soleal line transmitting the branch of the posterior tibial artery [14,15].

The study of the nutrient foramen holds an utmost importance in various clinical entities as it carry artery which is responsible for the supply of the bone [13].

Henceforth data pertaining to location of the nutrient foramen of the long bones is an essential prerequisite for the surgeons to perform various surgical procedures which will have a commendable outcome [2,3].

Also studying the morphometric measurements of the bone and nutrient foramen is useful for determining the whole length of a bone adding importance in some medicolegal aspects [4].

Preservation of the nutrient blood supply is considered as one of the most important aspects in promoting repair in vascular bone grafting [1,7].

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Several studies were performed determining the details of the nutrient foramen of the long bones.The present study has been undertaken to determine the morphology of the nutrient foramen of tibia in the body & comparing with the findings of the studies done previously.

Material and Methods

The study of 116 washed and dried tibia was done in G.S.L Medical College Rajahmundry. Deformed bones were excluded from the study. Age and gender of bone were not taken into account and to determine the sides of the bone universally accepted rules were followed. In the present study all the measurements were taken using sliding Vernier calliper and hypodermic needle of 24 gauge.

The following Observations were Taken

1.Number of nutrient foramen.

2.Type as Dominant or Secondary foramen.

3.Location as in upper 1/3rd, middle 1/3rd or lower 1/3rd - It was determine by the help of Foramina index (FI) using the formula:

FI = DNF/TL X 100

DNF – the distance from the proximal end of the bone to the nutrient foramen.

TL – total length of the bone.

Fig. 1: A photograph showing measurement of total length of the Right tibia measured by Vernier sliding calliper

Fig. 2: A photograpgh showing the measurement of DNF (distance from the proximal end of the bone to nutrient foramina using Vernier sliding calliper

The position of the Nutrient foramen was grouped into three types according to FI as follows [12]:

Type 1 – FI from 01 to 33.33

Nutrient foramen is in the proximal third of the bone

Type 2 – FI from 33.34 to 66.66

Nutrient foramen in the middle third of the bone

Type 3 – FI above 66.67

Nutrient foramen in the distal third of the bone

4. Location with respect to soleal line (medial, lateral or upon soleal line) was observed [8,14].
5. Size of the nutrient foramen – Nutrient foramen equal or larger than the size of 24 gauge hypodermic needle having the diameter of 0.56 mm were considered as Dominant nutrient foramen and less than this as the Secondary nutrient foramen [5].
6. Direction of the nutrient foramen – fine wire used to observe the direction & obliquity of the foramen [5].

Results

This study was undertaken on 116 dried tibia among which 69 were of right side & 47 left sided.

In right sided tibia 69 nutrient foramens were observed all directed downwards, of which 60 were the Dominant nutrient foramen & rest 9 were Secondary. By using foramina index it was stated that 58 of the Nutrient foramen were located in the upper third of the bone & remaining 11 were present in the middle third of the bone.With respect to soleal line 66 nutrient foramen were lateral to the soleal line & 3 were present upon it (Table 1,2 & 3).

Table 1: Type of Nutrient foramen and direction of foramen

Type of foramen	Right sided tibia direction	Left sided tibia direction
Dominant foramen	60, downward	38, downward
Secondary foramen	9, downward	9, downward
Dominant + Secondary Foramen	0	0

In left sided tibia 47 nutrient foramen were observed, all directed downward, 38 of them were considered as the Dominant nutrient foramen leaving other 9 as the Secondary one.Coming to the location using foramina index, 40 of the nutrient foramen were found to be in the upper third of the bone & rest 7 were in the middle third of the bone.With respect to soleal line, only 3 nutrient foramen were present on the soleal line, rest were found to be lateral to the soleal line (Table 1,2 & 3).

Fig. 2: A photograph showing the location of nutrient foramen in Right tibia in the upper third lateral to soleal line and directed downward sized .56mm

Table 2: Location of the Nutrient foramen

Sample side & Number	Upper 1/3rd	Middle 1/3rd	Lower 1/rd
Right (69)	58	11	0
Left (47)	40	7	0

Fig. 3: A photograph showing the location of the nutrient foramen upon the soleal line in the upper third of the three Right tibia (directed downwards)

Table 3: Nutrient foramen with respect to soleal line

Sample size and Side	Lateral to sole al line	Medial to sole al line	On sole al line
Right (69)	66	0	3
Left (47)	44	0	3

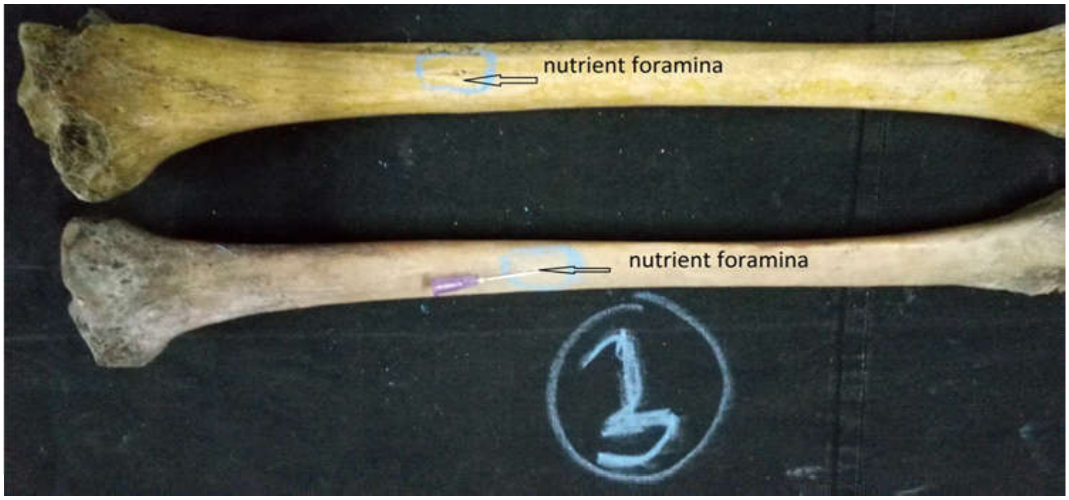

Fig. 4: A photograph showing the location of the nutrient foramen (lateral) in two of the tibia (directed downwards)

Table 4: Calculation of the Foramina index of the Right tibia

S. No of Right tibia	T.L	DNF	Type of Foramen	Direction	Foramina Index(FI) FI= DNF/TL X 100	Location	Sole al line
1.	35	19.6	D	downward	56	M1/3rd	L
2.	35.5	10.2	**S**	downward	28.7	U 1/3rd	L
3.	37	11.2	D	downward	30.27	U 1/3rd	L
4.	36	12.9	D	downward	35.8	M 1/3rd	L
5.	36.2	8.7	D	Downward	24	U 1/3rd	L
6.	34.5	10.6	D	Downward	30.7	U1/3rd	L
7.	36.3	12.1	D	Downward	33.33	M1/3rd	L
8.	35.5	11.6	D	Downward	32.6	U1/ 3rd	L
9.	38.2	13.2	D	Downward	34.5	M1/3rd	L
10.	35.4	9.2	D	Downward	25.9	U1/3rd	On sole al line
11.	38.1	12.4	D	Downward	32.5	U1/3rd	L
12.	35.8	11.3	D	Downward	31.5	U1/3rd	L
13.	33.9	11.7	D	Downward	34.5	M1/3rd	L
14.	36.1	10.1	**S**	Downward	27.9	U1/3rd	L
15.	41.4	13.2	D	Downward	31.8	U1/3rd	L
16.	38.5	10.2	D	Downward	26.4	U1/3rd	L
17.	34.9	8.2	D	Downward	23.4	U1/3rd	L
18.	34	10.6	**S**	Downward	31.1	U1/3rd	L
19.	35.6	10.2	D	Downward	28.6	U1/3rd	L
20.	36.5	11.6	D	Downward	31.7	U1/3rd	L
21.	36.6	9.3	D	Downward	25.4	U1/3rd	L
22.	36.8	11.8	D	Downward	32	U1/3rd	L
23.	38.9	9.8	D	Downward	25.1	U1/3rd	L
24.	35.8	10.2	D	Downward	28.4	U1/3rd	L
25.	38.2	11.1	D	Downward	29	U1/3rd	L
26.	39	14.9	D	Downward	38.2	U1/3rd	L
27.	35.7	10.4	D	Downward	29.1	U1/3rd	L
28.	34	8.3	D	Downward	24.4	U1/3rd	L
29.	33.3	11.4	D	Downward	34.2	M1/3rd	L
30.	39.5	11.6	D	Downward	29.3	U1/3rd	L
31.	35.4	7.4	**S**	Downward	20.9	U1/3rd	L
32.	37.4	10.4	D	Downward	27.8	U1/3rd	L
33.	38	11.9	D	Downward	31.3	U1/3rd	L
34.	36.6	11.8	D	Downward	32.2	U1/3rd	L
35.	36.6	9.4	D	Downward	25.6	U1/3rd	L
36.	37	14.5	D	Downward	39.1	M1/3rd	L
37.	37.7	10.4	D	Downward	27.5	U1/3rd	L
38.	32.2	10.2	D	Downward	31.6	U1/3rd	L
39.	40.1	12.1	D	Downward	30.1	U1/3rd	L
40.	39.4	14	D	Downward	35.5	M1/3rd	L

41.	37.5	13.4	D	Downward	35.7	M1/3rd	L
42.	38.7	10.4	D	Downward	26.8	U1/3rd	L
43.	35.4	10.5	D	Downward	29.6	U1/3rd	L
44.	34.8	11.8	D	Downward	33.9	M1/3rd	L
45.	38.5	12.6	D	Downward	32.7	U1/3rd	L
46.	36.3	10.3	D	Downward	28.3	U1/3rd	L
47.	31.8	9.3	**S**	Downward	29.2	U1/3rd	L
48.	33.6	11.4	D	Downward	33.9	U1/3rd	L
49.	36.8	10.4	D	Downward	28.2	U1/3rd	L
50.	31.3	8.6	**S**	Downward	27.4	U1/3rd	L
51.	31.7	9.4	D	Downward	29.6	U1/3rd	L
52.	27.4	7.5	D	Downward	27.3	U1/3rd	L
53.	38.8	10.2	D	Downward	26.2	U1/3rd	L
54.	29.5	10.1	D	Downward	34.2	M1/3rd	L
55.	34.8	11.4	D	Downward	32.7	U1/3rd	L
56.	36	11.3	D	Downward	31.3	U1/3rd	L
57.	32.6	9.8	D	Downward	30	U1/3rd	L
58.	35.4	10.9	D	Downward	30.7	U1/3rd	On sole al line
59.	37.2	13	D	Downward	34.9	M1/3rd	L
60.	36.8	9.8	D	Downward	26.6	U1/3rd	L
61.	35.2	11.3	D	Downward	32.1	U1/3rd	L
62.	36.9	11.4	D	Downward	30.8	U1/3rd	L
63.	36.7	11.4	D	Downward	31	U1/3rd	L
64.	37.2	11.5	D	Downward	30.6	U1/3rd	L
65.	37.8	12	**S**	Downward	31.7	U1/3rd	L
66.	39.4	10.4	D	Downward	26.3	U1/3rd	L
67.	32.6	9.8	**S**	Downward	30	U1/3rd	L
68.	33.8	11	**S**	Downward	32.5	U1/3rd	L
69.	32.6	9.8	D	Downward	30	U1/3rd	L

S. No of Left tibia	T.L	DNF	Type of foramen	Direction	Foramina Index(FI) FI=DNF/TL X100	Location	Sole al line
1.	33	13.2	D	Downward	40	M1/3rd	L
2.	36.2	11.4	D	Downward	31.4	U1/3rd	L
3.	38.2	11.8	D	Downward	30.8	U1/3rd	L
4.	34.8	9.4	D	Downward	27	U1/3rd	L
5.	37.4	10.5	D	Downward	28	U1/3rd	L
6.	37.5	15.3	**S**	Downward	40.8	M1/3rd	L
7.	38.6	11.4	D	Downward	29.5	U1/3rd	L
8.	34.2	11.2	D	Downward	32.7	U1/3rd	L
9.	37.2	11.1	D	Downward	29.8	U1/3rd	On soleal line
10.	35.3	12.8	D	Downward	36.2	M1/3rd	L
11.	40.1	11.8	D	Downward	29.4	U1/3rd	L
12.	35.6	10.9	D	Downward	30.6	U1/3rd	L
13.	38.5	11.8	D	Downward	30.6	U1/3rd	L
14.	40	10.4	D	Downward	26	U1/3rd	L
15.	38.5	11.6	D	Downward	30.1	U1/3rd	L
16.	39	9.4	D	Downward	24.1	U1/3rd	L
17.	34.4	10.6	D	Downward	30.8	U1/3rd	L
18.	35.9	10.3	D	Downward	28.6	U1/3rd	L
19.	40	12.6	D	Downward	31.5	U1/3rd	L
20.	37.5	10.2	D	Downward	27.2	U1/3rd	L
21.	36	9.8	D	Downward	27.2	U1/3rd	L
22.	38.7	11.2	D	Downward	31.3	U1/3rd	L
23.	38.1	10.6	D	Downward	27.8	U1/3rd	L
24.	28.6	7.4	**S**	Downward	20.9	U1/3rd	L
25.	39.3	9.8	D	Downward	24.9	U1/3rd	L
26.	36.8	12.6	D	Downward	34.4	M1/3rd	L
27.	35.8	10	D	Downward	27.9	U1/3rd	L
28.	33.4	11.1	D	Downward	33.2	U1/3rd	L
29.	35.3	10.8	**S**	Downward	30.5	U1/3rd	L
30.	36.3	11.3	D	Downward	31.1	U1/3rd	L
31.	33.2	9.5	D	Downward	28.6	U1/3rd	L

32.	32.6	10.4	S	Downward	31.9	U1/3rd	L
33.	35.7	10.8	S	Downward	30.2	U1/3rd	L
34.	37.8	10.1	D	Downward	26.7	U1/3rd	On sole al line
35.	35.6	13.1	D	Downward	36.7	M1/3rd	L
36.	38.3	11.4	D	Downward	29.7	U1/3rd	L
37.	32.7	10.1	S	Downward	30.8	U1/3rd	L
38.	31.5	9.7	D	Downward	30.7	U1/3rd	L
39.	33.8	11.4	D	Downward	34.5	M1/3rd	L
40.	36.8	23.4	D	Downward	63.5	M1/3rd	L
41.	38.5	11	D	Downward	28.5	U1/3rd	L
42.	34.8	9.4	S	Downward	27	U1/3rd	L
43.	36.6	10.2	D	Downward	27.8	U1/3rd	L
44.	36.6	10.9	D	Downward	29.7	U1/3rd	L
45.	39.6	12.4	S	Downward	31.3	U1/3rd	L
46.	38.1	12.2	D	Downward	32	U1/3rd	L
47.	36.7	11.4	S	Downward	31	U1/3rd	L

Discussion

In present study of 116 dried tibia 84% of the Nutrient foramen of the right side was located in the upper third of the bone & 85% were present in the upper third of the bone in the left sided tibia. Only 16% & 15% Nutrient foramen of the right & left sided respectively were found to be in the middle third of the bone. Distal third of the bone was devoid of Nutrient foramen suggesting that any injury leading to fracture will take more time in healing and repair or at times may go in phase of malunion [5,10].

This study of location of the Nutrient foramen was in accordance with the previous studies. Longia (1980) showed the location of the Nutrient foramen to be in the upper third of the bone in 91.0% of the cases whereas Krischner (1998) came up with the conclusion that Nutrient foramen was present in the upper third in 93.50% of the cases. Also Tejwasi H.L (2014) got the Nutrient foramen in the upper third in 94.90% of the cases [6,15].

In the present study all the Nutrient foramen were seen to be positioned on the posterior surface of the tibia directed downward and lying lateral to the soleal line.

In 95% cases of the right side it was lateral to soleal line whereas on the left side it was found to be in 93% of the cases.Similar findings were reported by Collipal (2007). He reported the Nutrient foramen to be lateral to soleal line in 94.33% of cases [3]. On the other hand Tejaswi H.L (2014) it was in 95.7% of cases [15].

Conclusion

The present study was in accordance and is confirmatory with the data given by the previous studies done by various researches. It provides useful information pertaining to the Nutrient foramen of the tibia and will surely help the surgeons to salvage the Nutrient artery while performing important surgical intervention like bone grafting and fracture repair.

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