

A STUDY ON DIAPHYSEAL NUTRIENT FORAMINA IN FEMUR

C. Siddaramulu¹, I. Vinayaka Naik², Arun Kumar S. Bilodi³

¹Associate Professor, Department of Anatomy, Rajiv Gandhi Institute of Medical Sciences, NTR University, Kadapa.

²Postgraduate, Department of Anatomy, Rajiv Gandhi Institute of Medical Sciences, NTR University, Kadapa.

³Professor, Department of Anatomy, Sri Mookambika Institute of Medical Sciences, MGR University Tamilnadu.

ABSTRACT

AIM OF THE STUDY

The objective of the present study is to know the positions, directions, number of nutrient foramina and their percentage of incidences in unknown dry femur bones obtained from the Department of Anatomy of Rajiv Gandhi Institute of Medical Sciences (RIMS), Kadapa.

PLACE OF STUDY

Unknown dry femur bones from the department of anatomy, Rajiv Gandhi Institute of Medical Sciences, Kadapa, Andhra Pradesh constituted the materials for the present study.

PERIOD OF STUDY

This study was done during the month of August-September of 2015.

MATERIALS & METHODS

Sixty four Unknown dry femora were studied in the department of anatomy of the above institution. Each femur was examined for the presence of number of nutrient foramina, their direction, their location was noted and their percentage of incidences was calculated.

RESULTS

The results of nutrient foramina in the femora were tabulated in various table forms respectively. On the right side of the shaft of the femur nutrient foramina 35.41% were in the upper 1/3rd, 58.3% were in the middle 1/3rd, 4.16% in the lower 1/3rd and 66.66% on the linea aspera, 12.5% on the lateral surface, 16.66% on the medial surface. On the left side of the shaft of femur nutrient foramina were 22.91% in the upper 1/3rd, 64.58% in middle 1/3rd, 2.08% in the lower 1/3rd and 43.75% on the linea aspera, 12.5% on the lateral surface and 31.25% on the medial surface.

KEYWORDS

Nutrient foramen, Nutrient canal, Fracture, Vascularity of the bones, Cortical portion, Long bones, Lower limbs, Periosteal artery, Osteoblast & Osteocyte cells.

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INTRODUCTION: A Nutrient foramina are the holes that allow the blood vessels to enter the cortical parts of the bones.¹ Nutrient artery enters the diaphysis of the bone obliquely with constant angulations and divides into ascending and descending branches after reaching the medullary cavity² The direction of the nutrient canal is very important to denote the growing end of long bones³ The vasculature must be preserved to promote repair of fractured area and a good supply is essential for the survival of osteoblast and osteocyte cells as well as to facilitate healing of graft in the recipient.⁴

MATERIALS AND METHODS: Sixty four Unknown dry femora were selected to study the presence of nutrient foramina, their direction, their location and their variations in the above femora from the department of anatomy, Rajiv Gandhi Institute of Medical Sciences [RIMS], Kadapa Andhra Pradesh.

Following parameters are studied:

1. Each femur was studied in detail for the presence of variations nutrient foramina, any accessory and multiple foramina.
2. Then their percentages of incidences were tabulated in various table forms.
3. Direction of the nutrient foramina were studied.
4. Distance of nutrient foramina from the lower end were measured.
5. Location of nutrient foramina was also observed.

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Corresponding Author:

Dr. C. Siddaramulu,

Associate Professor, Department of Anatomy,

RIMS Medical College, Putlampalli,

Kadapa-516001, Andhra Pradesh.

E-mail: dr.c.siddu@gmail.com

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OBSERVATION:

Right-Total No. of Nutrient Foramina 48								Left-Total No. of Nutrient Foramina 48							
Upper 1/3		Middle 1/3		Lowe 1/3		Linea aspera		Upper 1/3		Middle 1/3		Lowe 1/3		Linea aspera	
No.	%	No	%	No.	%	No.	%	No.	%	No	%	No	%	No	%
17	35.41	28	58.3	02	4.16	32	66.66	11	22.91	31	64.58	01	2.08	21	43.75

Table 1: Showing location of nutrient foramina on both right and left side and their percentages of incidences

Sl. No.	No. of Nutrient foramina	Position	Direction towards	Distance from lower end	Surface
1	2	1-middle1/3rd	upper end	17cms	Lateral to linea aspera
		2- middle1/3rd	lower end	27cms	On linea aspera
2	2	1-middle1/3rd	upper end	16cms	Lateral to linea aspera
		2- middle1/3rd	lower end	28cms	Medial to linea aspera
3	1	Middle1/3rd	upper end	20cms	On linea aspera
4	2	Middle1/3rd	upper end	18cms	Medial to linea aspera
		Middle1/3rd	upper end	23cms	On linea aspera
5	1	Lower 1/3rd	upper end	14 cms	Medial to linea aspera
6	2	1-middle 1/3rd	upper end	15 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	22 cms	Medial to linea aspera
7	1	Middle1/3rd	upper end	19 cms	Medial to linea aspera
8	1	Middle1/3rd	upper end	23 cms	On linea aspera
9	1	Middle1/3rd	upper end	20 cms	On linea aspera
10	2	1-middle 1/3rd	upper end	15 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	24 cms	On linea aspera
11	1	Middle1/3rd	upper end	17cms	Medial to linea aspera
12	2	1-middle 1/3rd	upper end	13cms	On linea aspera
		2-upper 1/3rd	lower end	25cms	On linea aspera
13	2	Middle1/3rd	upper end	16 cms	Medial to linea aspera
		Middle1/3rd	upper end	20 cms	On linea aspera
14	2	1-upper1/3rd	upper end	17 cms	On linea aspera
		2-middle 1/3rd	upper end	25cms	On linea aspera
15	2	1-middle 1/3rd	upper end	19 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	28 cms	On linea aspera
16	1	Middle1/3rd	upper end	24 cms	On linea aspera
17	1	Middle1/3rd	upper end	16 cms	Medial to linea aspera
18	1	Middle1/3rd	upper end	20 cms	Medial to linea aspera
19	1	Middle1/3rd	upper end	18 cms	Medial to linea aspera
20	2	Middle1/3rd	upper end	19 cms	On linea aspera
		Middle1/3rd	upper end	24 cms	On linea aspera
21	1	Middle1/3rd	upper end	20 cms	Medial to linea aspera
22	2	1-middle 1/3rd	upper end	14 cms	On linea aspera
		2-upper 1/3rd	upper end	24cms	On linea aspera
23	2	1-middle 1/3rd	upper end	20 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	28 cms	On linea aspera
24	2	1-middle 1/3rd	upper end	17 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	26 cms	On linea aspera
25	2	1-middle 1/3rd	upper end	18 cms	On linea aspera
		2-upper 1/3rd	upper end	30 cms	On linea aspera
26	1	Middle1/3rd	upper end	18 cms	Medial to linea aspera
27	2	1-middle 1/3rd	upper end	16 cms	On linea aspera
		2-upper 1/3rd	upper end	26 cms	On linea aspera

28	2	1-middle 1/3rd	upper end	18 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	27 cms	On linea aspera
29	2	Middle1/3rd	upper end	17 cms	On linea aspera
		Middle1/3rd	upper end	22 cms	On linea aspera
30	2	Middle1/3rd	upper end	16 cms	On linea aspera
		Middle1/3rd	upper end	25 cms	On linea aspera

Table 2: Showing the number, position, directions, distance from the lower end and surfaces of femora belonging to the left side

Right side					
Sl. No.	No. of Nutrient foramina	Position	Direction towards	Distance from lower end	Surface
1	1	Middle1/3rd	upper end	16cms	On linea aspera
2	2	1-middle1/3rd	upper end	15cms	Lateral to linea aspera
		2- upper 1/3rd	upper end	20cms	On linea aspera
3	1	upper 1/3rd	upper end	23cms	On linea aspera
4	2	Middle1/3rd	upper end	16cms	On linea aspera
		Middle1/3rd	upper end	20cms	On linea aspera
5	1	Middle 1/3rd	upper end	23 cms	On linea aspera
6	2	1-middle 1/3rd	upper end	18 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	26cms	On linea aspera
7	1	upper 1/3rd	upper end	26 cms	On linea aspera
8	2	1-middle 1/3rd	upper end	15 cms	On linea aspera
		2-upper 1/3rd	upper end	27 cms	On linea aspera
9	1	middle 1/3rd	upper end	16 cms	On linea aspera
10	2	1-middle 1/3rd	upper end	15 cms	On linea aspera
		2-upper 1/3rd	upper end	24 cms	On linea aspera
11	1	Middle1/3rd	upper end	18cms	Lateral to linea aspera
12	2	Middle1/3rd	upper end	16cms	On linea aspera
		Middle1/3rd	upper end	22cms	On linea aspera
13	1	Middle1/3rd	upper end	22 cms	On linea aspera
14	2	1-middle 1/3rd	upper end	21 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	30 cms	On linea aspera
15	1	Middle1/3rd	upper end	17 cms	Lateral to linea aspera
16	1	Lower 1/3rd	upper end	10 cms	On linea aspera
17	1	Middle1/3rd	upper end	20 cms	Medial to linea aspera
18	1	Middle1/3rd	upper end	17 cms	Medial to linea aspera
19	2	1-middle 1/3rd	upper end	16 cms	On linea aspera
		2-upper 1/3rd	upper end	26 cms	On linea aspera
20	1	Middle1/3rd	upper end	18 cms	Medial to linea aspera
21	1	Upper 1/3rd	upper end	26 cms	On linea aspera
22	1	Middle1/3rd	upper end	18 cms	Medial to linea aspera
23	2	1-upper 1/3rd	upper end	25 cms	On linea aspera
		2-middle 1/3rd	upper end	18 cms	Lateral to linea aspera
24	2	1-middle 1/3rd	upper end	16 cms	Lateral to linea aspera
		2-upper 1/3rd	upper end	28 cms	On linea aspera
25	2	1-middle 1/3rd	upper end	19 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	27 cms	On linea aspera
26	2	1-middle 1/3rd	upper end	17 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	27 cms	On linea aspera
27	2	1-middle 1/3rd	upper end	18 cms	Medial to linea aspera
		2-upper 1/3rd	upper end	28 cms	On linea aspera
28	1	Middle1/3rd	upper end	16 cms	On linea aspera
29	2	Upper 1/3rd	upper end	25 cms	On linea aspera
		Upper 1/3rd	upper end	21 cms	On linea aspera
30	2	1-middle 1/3rd	upper end	15 cms	On linea aspera
		2-upper 1/3rd	upper end	27 cms	Medial to linea aspera
31	1	Lower 1/3rd	upper end	13 cms	On linea aspera
32	1	Upper 1/3rd	upper end	25 cms	On linea aspera
33	1	Middle1/3rd	upper end	18 cms	On linea aspera
34	1	Middle1/3rd	upper end	17 cms	On linea aspera

Table 3: Showing the number, position, directions, distance from the lower end and surfaces of femora belonging to the right sides

OBSERVATIONS: On the right side: Highest number of nutrient foramina were on linea aspera followed by in the middle 1/3rd and least number were found in lower 1/3rd.

On the left side: Highest number of nutrient foramina were in the middle 1/3rd followed by in the linea aspera and least number were found in lower 1/3rd.

1. Total number of unknown dry bones: 64 bones.
2. Bones without nutrient foramina: nil.
3. Bones more than one nutrient foramina: 32 bones.
4. Direction of Nutrient Foramina towards upper end: 93 Nutrient Foramina.
5. Direction Nutrient Foramina towards lower end: 03 Nutrient Foramina.
6. Number of nutrient foramina in upper 1/3rd:28.
7. Number of nutrient foramina in middle 1/3rd:59.
8. Number of nutrient foramina in lower 1/3rd:03.
9. Number of nutrient foramina on linea aspera:53.
10. Maximum distance of nutrient foramina:30 cms.
11. Minimum distance of nutrient foramina:10 cms.
12. More number of nutrient foramina are in between:13 to 20 cms.
13. Percentage of nutrient foramina lateral to linea aspera: 12.5%.
14. Percentage of nutrient foramina medial to linea aspera: 23.95%.
15. Percentage of nutrient foramina on linea aspera: 55.20%.
16. Percentage of nutrient foramina in middle 1/3rd:51.04%.
17. Percentage of nutrient foramina in lower 1/3rd:3.12%.



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

DISCUSSION: Nutrient artery enters the nutrient foramen into the shaft passes through the cortex divides into ascending and descending branches in the medullary cavity. Each branch again divides into many small parallel branches and anastomosing with epiphyseal, metaphyseal and periosteal arteries. Nutrient artery supplies medullary cavity, 2/3rd of the cortex and metaphysis. Nutrient foramen always directed away from the growing end of the bone and follows a saying, to the elbow I go and to the knee I flee.⁵

Shyam Sundar Rao and Jyothinath Kothapalli (2014) did a study on nutrient arteries and peripheral nerves on the shaft of long bones. They conducted the study in the department of anatomy, MNR Medical college, Sangareddy, Medak, A. P. and Government Medical College, Aurangabad, Maharashtra on 1320 bones (840 males, 480 females) femur which showed highest number of nutrient foramina in 2nd segment in males and females, only 1% multiple nutrient foramen in 2nd segment; 2 nutrient foramen found in 68% of femur, 14% in tibia, 20% in fibula, 10% in humerus, which it was less in females.⁶ In my study highest number of nutrient foramina were on linea aspera (55.20%).⁶

Raj Kumar et. al, (2013) studied on the position and number of nutrient foramen in adult femur bones. The study showed location of nutrient foramen in the middle 1/3rd of diaphysis mainly around linea aspera 57.32%. The mean foraminal index was 57.32%. This study was done in the population of Rohilkhand region, U.P of India. This study was useful in surgical procedure and interpretation in radiological images⁷ The Blood supply to the long bone is by nutrient artery which enter the bone through nutrient foramina which is directed always from the growing end.⁸

Peiraira et al conducted a study on 885 long bones of southern Brazil. Out of them, 174 were humerii, 157 radii, 146 ulna, 152 femora, 142 tibia and 114 fibula bones. The majority of nutrient foramina were located on the anterior aspect of the upper limb long bones and on the posterior aspect of lower limb long bones. The majority of the bone that were studied had only one nutrient foramina and that was the single source of blood supply. The mean foramina index for the upper limb bone was 55.2% for the humerus, 35.7% for the radius and 37.9% for the ulna.

In the Lower limb, 43.7% for the femur, 32.75 for the tibia 46.1% for the fibula. This study provides the ethnic data which was commonly used for comparison and Interpretation for surgical image.⁹

Sharma et al [2015] studied on 55 femora, 50 tibia and 50 fibula in the department of Anatomy at Punjabi Institute of Medical sciences, Jalandhar, Punjab, India. In femur, their

study showed 54% had single nutrient foramina, 42% had double foramina and 2% had triple foramina and it was absent in 2% of femur bone.¹⁰

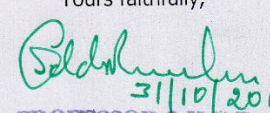
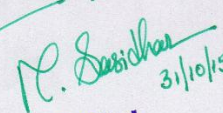
The Periosteal arteries is only the source of blood supply when the bones do not have nutrient foramina and nutrient arteries¹¹ The only source of blood supply and important during growing period of the embryo as well as in foetus during early phase of ossification is the nutrient artery.¹² In orthopaedic surgical procedures like joint replacement therapy, fracture of bones, bone graft and vascular bone microsurgeries, the knowledge of position and number of nutrient foramina is very essential.¹³

Present study: Our study has been done on 64 unknown dried femur bones in Rayalaseema region of Andhra Pradesh. Out of which, right sided: 34 femorii showed 48 nutrient foramina; while on the left sided: 30 femorii showed 48 nutrient foramina, total foramina found were 96 nutrient foramina; Among them 55.20% showed nutrient foramen on

the linea aspera, 51.04% on the middle 1/3rd of diaphysis, followed by 29.16% in the upper 1/3rd, followed by 3.12% in the lower end and 12.25% are lateral to linea aspera and 23.95% are medial to linea aspera both on right and left sided femora. No femur had any absence of nutrient foramen.

CONCLUSION: The study is of paramount clinical importance in case of fractured bones for restoration of vasculature. This study also gives knowledge of presence and variations of nutrient foramen of long bones especially for the orthopaedic surgeons.

Take Home Message: The vasculature of long bone (femur) must be preserved in the fractured area to promote repair of and to get good supply which is very essential to facilitate healing of graft in the recipient. Hence it has been studied and reported.

From	Date: 31-10-2015, Place: Kadapa.
I/C H O D, Department of anatomy RIMS Medical College, Kadapa, Andhra Pradesh.	
TO	
The principal, RIMS Medical College, Kadapa.	
Respected sir,	
Sub: Request to give permission for various studies in department of anatomy to publish papers in international index journals request - Regarding.	
>>><<<	
As cited above, in the department of anatomy we are using dry bones, various specimens and human cadavers for various studies and research activities as a part of academic activity, hence we request you to give permission to publish these studies in international indexed journals.	
Thanking you,	
Yours faithfully,	
 31/10/2015 PROFESSOR & H.O.D Department of ANATOMY, RIMS Medical College KADAPA (DR. C. SEDDARAMULU)	
<i>Permitted as its academics.</i>  31/10/15 Principal RIMS Medical College, KADAPA.	

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