International Journal of Anatomy and Research,
Int J Anat Res 2020, Vol 8(1.3):7378-82. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2020.107

Original Research Article

MORPHOLOGICAL AND MORPHOMETRIC STUDY OF NUTRIENT FORAMINA OF FEMUR IN SOUTH INDIAN POPULATION

Abhijit K R [1], Prathap Kumar J [*2], Shailaja Shetty [3].

[1] Intern, M.S.Ramaiah Medical College, Bangalore, Karnataka, India.

[*2] Assistant Professor, Department of Anatomy, M.S.Ramaiah Medical College, Bangalore, Karnataka, India.

[3] Professor & HOD, Department of Anatomy, M.S.Ramaiah Medical College, Bangalore, Karnataka, India.

ABSTRACT

Background: The knowledge of variations in the position of nutrient foramina and hence nutrient arteries is important for orthopedicians and radiologists for various procedures.

Introduction: The major blood supply to long bones occurs through the nutrient arteries, which enter through the foramina called nutrient foramina. The blood supply from nutrient artery is essential during the growing period, also during the early phases of ossification, and in procedures such as bone grafts, transplant techniques in orthopaedics. The present study analyzed the position and number of nutrient foramina in the diaphysis of fifty adult femora.

Aim: to determine the number, direction, position of nutrient foramen and whether the nutrient foramina obey the general rule that is, directed away from the growing end of the bone

Materials and Method: The present study has been undertaken in Fifty dry adult femora of South Indian origin in the Department of Anatomy, M.S Ramaiah Medical College, Bangalore. The number, directions, position of nutrient foramen in femur were measured with a digital Vernier caliper. The data were tabulated as mean ± SD and statistically compared between the right and left sides.

Results: A total of 75 foramina were examined in the 50 bones. 40 in Right sided femur and 35 in left sided femur. 46% bones had single foramina and 52% bones had double foramina. Foramen was absent in 2% bones. All nutrient foramina in the femur were directed proximally, away from the growing end. 16% of the foramina were located in the proximal third of the bone and the rest 84% were located in the middle third of the bone. There was no significant difference in location of foramina between right and left sided bones.

Conclusion: This study will provide the ethnic data for comparison among various populations. It is also helpful in interpretation of radiological images and for orthopedic procedures. Precise knowledge of usual and anomalous position of nutrient foramina and hence the nutrient artery may help the orthopaedician for the internal fixation at appropriate place in the long bone. The location of nutrient foramen is important for bone grafts, tumour resections, in traumas, congenital pseudoarthrosis and more recently in microsurgical vascularised bone transplantation.

KEY WORDS: Nutrient Artery, Diaphysis, Long Bone, Internal Fixation, Bone Graft, Bone Transplantation.

Corresponding Author: Dr Prathap Kumar J, Assistant Professor, Department of Anatomy, M S Ramaiah Medical College, M S R Nagar, MSRIT post, Mathikere, Bangalore, Karnataka, India- 560054. Ph No. 9743989426 **E-Mail:** dr.prathapkumar@gmail.com

Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research
	RG Journal Impact: 0.21*
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2020.107	

Article Information	
Received: 17 Jan 2020	Accepted: 12 Feb 2020
Peer Review: 18 Jan 2020	Published (O): 05 Mar 2020
Revised: None	Published (P): 05 Mar 2020

INTRODUCTION

The long bone is supplied mainly by Nutrient artery along with periosteal arteries. At every region, the regional artery will give rise to the nutrient artery. Nutrient foramen is a foramen found in the shaft of a long bone which permits the entry of the nutrient artery. Nutrient foramen is an opening in the shaft of long bone which conducts the nutrient arteries and the peripheral nerves into the medullary cavity of a long bone.

One or two main diaphyseal nutrient arteries enter the shaft obliquely through one or two nutrient foramina leading to nutrient canals. Most of the long bones have a single nutrient foramen, except for a few with double or no foramina are found.

Nutrient canal typically become slanted during growth, the direction of slant from surface to marrow cavity points towards the end that has grown least rapidly. The direction of nutrient foramen of all bones is away from growing end. The nutrient foramina in the long bones of human limbs are described as being directed towards the elbow and away from the knee. This is because of the reason that one end of long bones grow faster than the other [1].

During the growing period of long bone, during the early phases of ossification, and in procedures such as bone grafts, tumour resections, traumas, congenital pseudoarthrosis and more recently in microsurgical vascularised bone transplantation, the nutrient arterial supply is very essential [2].

MATERIALS AND METHODS

An osteological study on nutrient foramina in femora, was conducted in Department of Anatomy, M.S.Ramaiah Medical College Bangalore, Karnataka, India. This study was done in 50 dry adult femora. Each bone is examined in detail for the number, position & direction of nutrient foramina. The nutrient foramen is identified by the presence of a well marked groove and raised edge at the commencement of the canal. All measurements were taken with osteometric board and digital Vernier calipers. The direction of the nutrient foramen was noted with the help of a probe.

Inclusion Criteria: Adult human femora irrespective of sex, race was taken for study.

Exclusion Criteria: Femora showing any pathological changes, gross asymmetry or fractured and deformed bones were rejected as they were unsuitable for the study.

The following were noted:

1. Number of nutrient foramina: Out of 50 bones, 25 right & 25 left femur were examined for the number of nutrient foramina

2. Direction of nutrient foramen: The groove distal to the nutrient foramen was taken as a reference to identify the direction of the nutrient foramen

3. Location of nutrient foramen: Foraminal index (FI) = (DNF/TL) x 100

- DNF = the Distance from the proximal end of the bone to the Nutrient Foramen.
- TL = Total Length of bone
- Type 1: FI up to 33.33, the foramen was in the proximal third of the bone
- Type 2: FI from 33.33 to 66.66, the foramen was in the middle third of the bone
- Type 3: FI above 66.66, the foramen was in the distal third of the bone

Statistical Analysis: Data analysis was done using Microsoft Excel and SPSS 17. Data was summarised using percentages, range, mean and standard deviation. P value <0.05 was considered as statistically significant to compare parameters between Right and Left sided bones

RESULTS

Number: 23 bones (46%) had single foramina and 26 bones (52%) had double foramina. Foramen was absent in 1 bone (2%). There was so significant difference in number of foramina between right and left sided bones.

Direction: All nutrient foramina in the femur were directed proximally, away from the growing end.

Location: A total of 75 foramina were examined in the 50 bones. 40 in Right sided femur and 35 in left sided femur. 16% of the foramina were located in the proximal third of the bone and 84% were located in the middle third of the bone. There was no significant difference in location

of foramina between right and left sided bones.

The nutrient foramina in 50 femora studied are shown in **Table 1.**

The presence single nutrient foramen directed proximally and present in the proximal 1/3rd of femur is shown in **figure 1**.

The presence double nutrient foramina, both directed proximally and both present in the proximal 1/3rd of femur is shown in **figure 2**.

The presence single nutrient foramen directed proximally and present in the proximal 1/3rd of femur is Type 1, and middle 1/3rd is Type 2 is shown in **figure 3**.

The main nutrient foramina and the accessory nutrient foramina were directed upwards in all the femora studied. This shows that the growing end of femora were the lower ends. The number and location of nutrient foramina in 50 femora are shown in **Table 2 and Table 3** respectively.

The femoral index of right and left femur is shown in **Table 4.**

Location of Nutrient foramina in femur & Foramen Index and comparison between right and left sides is shown in **Table 5.**

Table 1: Showing the number of nutrient foramina in femur.

Nutrient Foramina of Femur	
No. of bones examined	50 (100%)
Single foramina	23 (46%)
Double foramina	26(52%)
Absent foramina	1 (2%)

Table 2: Number of nutrient foramina in right and left femur.

Side	Single foramen	Double foramen
Right Femur	10 (40%)	15(60%)
Left Femur	13 (52%)	11(44%)

Table 3: Location of Nutrient foramina in femur & Foramen Index.

Location	Proximal 1/3rd	Middle 1/3rd	Distal 1/3rd
Number (%)	12 (16%)	63 (84%)	0 (0%)
Foramen Index	Range (%)	Mean ±SD	
	27.81 – 66.59	44.13±10.89	

Table 4: showing the right & left foramen index of femur.

Foramen index		
	Range (%)	Mean ±SD
Right side	28.90-66.59	43.57±9.65
Left Side	27.81-63.57	44.29±11.19

Table 5: Location of Nutrient foramina in femur & Foramen Index and comparison between right and left sides.

	Location of nutrient foramen in femur		
Side	Proximal 1/3rd	Middle 1/3rd	Distal 1/3rd
Right side	6(15%)	34 (85%)	0
Left side	6(17.4%)	29(82.86%)	0
Foramen Index	Side	Range (%)	Mean ±SD
	Right side	28.90 - 66.59	43.57±9.65
	Left side	27.81 - 63.57	44.29±11.19

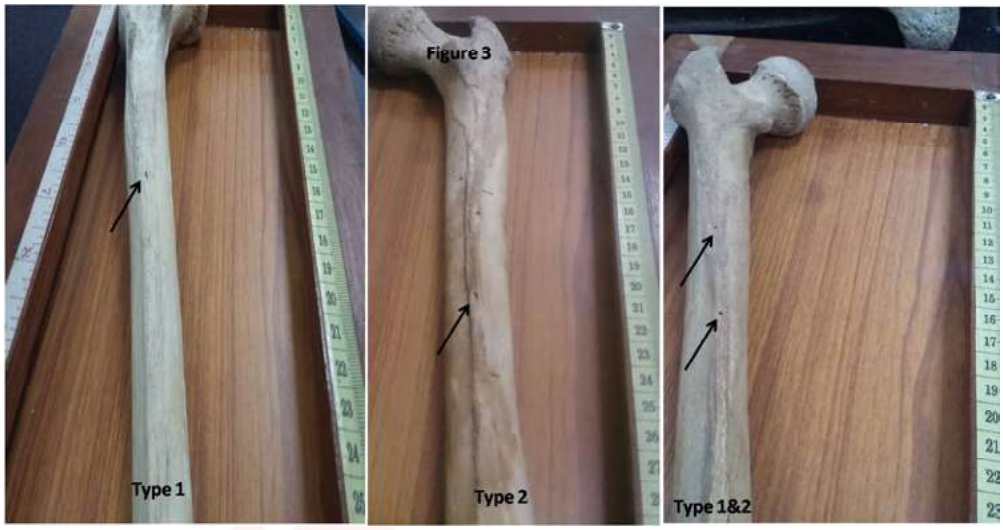
Table 6: The present study of location of nutrient foramina of femora were compared with the previous similar studies.

Sl.No.	Author (year)	Location of the Nutrient foramina
1	Lutken (1950) [10]	Proximal 1/3
2	Mysorekar (1967) [4]	Middle 1/3
3	Longia et al. (1980) [11]	Middle 1/3
4	Campos et al. (1987) [6]	Proximal 1/3
5	Sendmir et al (1991) [12]	Middle 1/3
6	Gumusburun et al. (1994) [13]	Middle 1/3
7	Collipal et al. (2007) [14]	Middle 1/3
8	Kizilikanat et al. (2007) [8]	Middle 1/3
9	Kumar et al. (2013) [15]	Middle 1/3
10	Present Study (2015-19)	Middle 1/3

Fig. 1: Single nutrient foramen directed proximally and present in the proximal 1/3rd of femur.

Fig. 2: The presence double nutrient foramina, both directed proximally and both present in the proximal 1/3rd of femur.

Fig. 3: Based on Foraminal index, there are 3 types of Nutrient foramina.



DISCUSSION

The nutrient foramina are cavities that conduct the nutrient arteries and the peripheral nerves on the shaft of long bones. Long bones receive most of the interosseous blood supply from the nutrient arteries, and sometimes through the periosteal vessels. Nutrient arteries play an important role in nutrition and growth of the bones particularly during its growth period in the embryo and fetus as well as during early phases of ossification [3].

The direction of nutrient foramina in human long bones is directed away from the growing end. This is due to one end of long bone growing faster than the other end [4].

In many tetra pods**,** there is variation in the directions of nutrient foramina, but in mammals and birds Hughes pointed out that Anomalous canal are frequent, especially in femur [5].

The nutrient foramen is defined as the largest of the foramen present on the shaft of long bone allowing nutrient artery to enter the bone, the role of which is important in providing nutrition and growth of long bones.

An understanding of the location and the number of the nutrient foramina in long bones is therefore important in orthopedic surgical procedures such as joint replacement therapy, fracture repair bone grafts and vascularized bone microsurgery as well as medico legal cases [3].

The surgical exposure and periosteal stripping in open reduction internal fixation in 65 procedures of diaphyseal fractures present further vascular insult to existing osseous injury [6].

The number of nutrient foramina present in the humerus and femur. The majority of the investigated bones had a single nutrient foramen. Occasionally, double foramina were observed in humerus and double or triple nutrient foramina in the femur [7].

An understanding of the position and number of the nutrient foramina in long bones is important in orthopaedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery [8].

Importance of nutrient foramen is relevant to fracture treatment. Combined periosteal and medullary blood supply to the bone cortex helps to explain the success of nailing of long bone fractures [9].

Clinical Significance: Position and number of the nutrient foramina in long bones is very important in orthopedic surgical procedures like joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery [8].

Exact location and distribution of the nutrient foramina in bone diaphysis is important to avoid damage to the nutrient vessels during surgical procedures [15].

Embryological Significance: The forces responsible for the determination of the direction of nutrient canal is hard to find out. Le Gros Clark in 1939 gave the most precise explanation. “The nutrient foramen and the canal of the shaft of a long bone are always directed obliquely away from the growing end of the bone, i.e. in the upper limb towards the elbow and in the lower limb away from the knee. This obliquity is a

necessary consequence of the mode of growth in length of the bone. The nutrient artery, which is a branch of a main artery in the particular region, runs directly into the shaft, entering it at right angles. As the shaft extends in length away from the growing end the artery is carried with it, so that its entrance becomes more and more oblique in a direction towards the opposite extremity of the bone" [16].

CONCLUSION

The direction of the nutrient foramen is important in knowing the growing end of the long bone. In bone grafts, the nutrient blood supply is crucial and it should be preserved in order to promote the fracture healing. Its knowledge is of importance to the orthopaedic surgeons and oncologists. The number of nutrient foramina in femurs is either one or two with rare variations, which are not statistically significant. The nutrient foramina of femora are directed proximally with rare variations, which are not statistically significant. The nutrient foramina of femora are located in and around the linea aspera in the middle third of the bone, with a few in the proximal third, in the South Indian population and in most of the other studies, but a few studies suggest its presence closer to the hip joint. The knowledge about these foramina is useful in the surgical procedures to preserve the circulation.

Knowledge of the number, direction and location of nutrient foramina of femur may be of use to anatomists, orthopaedics and radiologists. It is of utmost importance for the orthopaedic surgeons during procedures like bone grafting and more recently in microsurgical vascularised bone transplantation. One of the femur had no nutrient foramen. This suggests that in case of obliteration of nutrient foramen, the epiphyseal artery might have taken up the responsibility for supplying the bone.

Conflicts of Interests: None

REFERENCES

[1]. Grey H, Williams P.L., Bannister L.H, Berry M.M, Collins P, Dyson M, Dussek J.E, Ferguson M.W.J. et al.1995. Gray's Anatomy: 38 edition. London, Churchill Livingstone. 1995: 1417.

[2]. Pereira G.A.M, Lopes P.T.C, Santos A.M.P.V, Silveira F. H. S. Nutrient foramina in the upper and lower limb long bones: Morphometric Study in Bones of Southern Brazilian Adults. Int. J. Morphol. 2011; 29(2): 514-520.

[3]. Rao V.S, Kothapalli J. The Diaphyseal nutrient foramina architecture - a study on the human upper and lower limb long bones. IOSR Journal of Pharmacy and Biological Sciences. 2014;9(1): 36-41.

[4]. Mysorekar VR. Diphysial nutrient foramina in human long bones. J Anat. 1967; 101(4): 813-822.

[5]. Hughes H. The factors determining the direction of canal for the nutrient artery in the long bones of mammals and birds. Acta Anat. 1952; 15(3): 261-280.

[6]. Campos F.F, Pellico L.G, Alias M.G, Fernandez-Valencia R. A study of the nutrient foramina in human long bones. Surg. Radiol. Anat. 1987; 9: 251 – 255.

[7]. Skawina A, Litwin J.A, Gorzyca J, Miodonski A.J. The vascular system of human fetal long bones: A scanning electron microscope study of corrosion casts. J. Anat. 1994; 185: 369 – 376.

[8]. Kizilkanata E, Boyana N, Esin T. Ozsahina, Roger Soamesb R, Oguza O.Location, number and clinical significance of nutrient foramina in human long bones. Ann. Anat. 2007; 189: 87 – 95.

[9]. Malukar O, Joshi H. Diaphysial nutrient foramina in long bones and miniature long bones. NJIRM; 2011; 2: 23-26.

[10]. Lutken P. Investigation into the position of the nutrient foramina and the direction of the vessel canals in the shafts of the humerus and femur in man. Acta anat. 1950; 9: 57 - 68.

[11]. Longia G.S, Ajmani M.L, Saxena S.K, Thomas R.J. Study of diaphyseal nutrient foramina in human long bones. Acta Anat. Basel. 1980; 107: 399 – 406.

[12]. Sendemir E, Cimen A. Nutrient foramina in the shafts of lower limb long bones: situation and number. Surg. Radiol. Anat. 1991; 13: 105 – 108.

[13]. Gumusburun E, Yucel F, Ozkan Y, Akgun Z. A study of the nutrient foramina of lower limb long bones. Surg. Radiol. Anat. 1994; 16: 409 – 412.

[14]. Collipal E, Vargas R, Parra X, Silva H, Sol M. Diaphyseal nutrient foramina in the femur, tibia and fibula bones. Int. J. Morphol. 2007; 25 (2): 305 – 308.

[15]. Kumar R, Mandloi R.S, Singh A.K, Kumar D, Mahato P. Analytical and morphometric study of nutrient foramina of femur in rohilkhand region. Innovative Journal of Medical and Health Science.2013; 3(2): 52 - 54.

[16]. Le Gros Clark WE. The tissues of the body, 6th edn. Oxford: ELBS. 1980; 79-80,105.

How to cite this article: Abhijit K R, Prathap Kumar J, Shailaja Shetty. MORPHOLOGICAL AND MORPHOMETRIC STUDY OF NUTRIENT FORAMINA OF FEMUR IN SOUTH INDIAN POPULATION. Int J Anat Res 2020;8(1.3):7378-7382. **DOI:** 10.16965/ijar.2020.107