
**ISSN Print:** 2394-7500
**ISSN Online:** 2394-5869
**Impact Factor:** 5.2
IJAR 2016; 2(3): 08-11
www.allresearchjournal.com
Received: 04-01-2016
Accepted: 05-02-2016

**Agrawal Nidhi**
Demonstrator, Department of Anatomy, NSCB Medical College Hospital Jabalpur-482003, MP, India.

**Arjun Singh Parmar**
S.S. Medical College. Rewa MP., India.

**DC Naik**
Professor & Head. S.S. Medical College. Rewa, MP, India.

**Correspondence**
**Agrawal Nidhi**
Demonstrator, Department of Anatomy, NSCB Medical College Hospital Jabalpur-482003, MP, India.

# Correlation between number and size of nutrient foramina to bone length: An anatomical study in lower limb long bones

**Agrawal Nidhi, Arjun singh Parmar, DC Naik**

**Abstract**
**Background:** The maintenance of normal longitudinal growth of bone is dependent upon a sufficient blood supply to the region of the epiphyseal cartilage line. Long bones are supplied by a nutrient artery that enters individual bones obliquely through a nutrient foramen. The aim of our study was to determine the number, position and size of nutrient foramina and if correlation exists between the length of the bone and number of nutrient foramina.
**Material and Method:** The study was done in Department of Anatomy, S.S. Medical College Rewa (M.P.). 201 adult human long bones of lower limb were collected from Department of Anatomy.
**Results:** In respect to number of nutrient foramina majority of bones have single nutrient foramina and most of the bones possesses dominant foramina. No correlation was noted between number of nutrient foramina and length of the bone.
**Conclusion:** The findings in the present study was compared and analyzed with previous researchers. Information obtaining from anatomical description of these foramina is helpful to preserve the circulation of affected bony structures during orthopedic surgeries. It is also of relevance for those clinicians involved in surgical procedures where patency of the arterial supply to long bones is important.

**Keywords:** Lower limb long bones, Nutrient foramina (NF), Foraminal Index (FI), Dominant foramina (DF), Secondary foramina (SF), Total bone length (TL).

## 1. Introduction
Every long bone is supplied by number of arteries entering it through all aspects except areas covered by articular cartilage [1].The blood supply to long bones are classically divided into three sets, medullary nutrient, epiphyseal – metaphyseal and Periosteal [2].The pathway for the nutrient artery comprises the nutrient foramen (NF) and nutrient canal (NC) on the diaphysis of long bones. Knowledge of these pathways is essential to conserve the main vessels during orthopaedic surgical procedures, such as bone grafting and fracture repair [3]. A nutrient artery is the principal source of blood supply to a long bone and is particularly important during its active growth period in the embryo and fetus, as well as during the early phase of ossification [4, 5]. During childhood, long bones receive about 80% of the interosseous blood supply from the nutrient arteries and in the case of their absence, the vascularization occurs through the periosteal vessels (Trueta, 1953). When this supply is compromised, medullary bone ischemia occurs with less vascularization of the metaphysis and growth plate [6]. So our present study focused to analyze the correlation between anatomical variation of nutrient foramina number and size to the bone length.

## 2. Materials and Methods
Random collection of 201cleaned and dried long bones of human lower limb ie femur {81}, tibia {70} and fibula {50} of both sides which are grossly normal and complete, obtained from the Department of Anatomy**,** S.S. Medical College Rewa (M.P.).All the bones belong to Indian subjects, the age and gender of which are not determined. After determining the side of each bone, they are serially numbered and photographed. The nutrient foramina are observed in all bones with the help of a hand-lens. They are identified by their elevated margins and by the presence of a distinct groove proximal to them [7]. Only well-defined foramina on the diaphysis are accepted. Foramina at the ends of the bone are ignored [8].

**The following data is studied on the diaphyseal nutrient foramina of each bone**

**(A) Number:** Bones were examined for the number of nutrient foramina. With the help of magnifying hand lens all surfaces and each border was thoroughly examined from proximal to distal end and both dominant and secondary foramina were counted and noted down.

**(B) Position:** The positions of all nutrient foramina were determined by calculating a foraminal index (FI) by using formula:

**FI = (DNF/TL) x 100** (Hughes1952; shulman 1959)

**DNF** = the distance from the proximal end of the bone to the nutrient foramen

**TL** = Total bone length.

**The total length of the individual bone was measured as below**

**Femur:** The distance between the proximal aspect of the head of the femur and the most distal aspect of the medial condyle [9].

**Tibia:** The distance between the proximal margin of inter-condylar eminence and the tip of the medial malleolus [9].

**Fibula:** The distance between the apex of the head of the fibula and the tip of lateral malleolus [9].

**(C) Size:** Nutrient foramina smaller than the size of 24 hypodermic needle (0.56 mm in diameter) were considered as secondary nutrient foramina (S.F.) while those equal or larger than 0.56mm were accepted as dominant nutrient foramina(D.F.) [10, 11].

All measurements have taken to the nearest 0.02 mm using an Aerospace sliding caliper. Photographs were taken in natural daylight by a Nikon digital Camera of 10 megapixels. Each photograph had a definition of 16 x 12 cm.

## 3. Results

The results were analyzed and tabulated using the range, mean and standard deviation of foramina index determined

**Table 1:** Number of nutrient foramina observed in long bones of lower limb

| Bone | Number of foramina | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| Femur | - | 87 | 54 | - |
| Tibia | - | 70 | - | - |
| Fibula | 2 | 58 | - | - |

**Table 2:** Foraminal index and measurements associated with Dominant nutrient foramina in the long bones of lower limb

| Measurements | Femur | Tibia | Fibula |
|---|---|---|---|
| DNF | 20.42±9.87 | 12.54±3.38 | 12.88±1.77 |
| TL | 43.67±2.04 | 37.75±3.32 | 35.80±2.53 |
| FI | 46.29±2.46 | 32.96±6.06 | 39.66±5.29 |

Data includes means and standard deviation

Abbreviations: DNF = Distance of the nutrient foramen from the proximal end of the bone. TL = Total length of bone; FI = Foraminal Index.

**Table 3:** Range, Mean ± Standard deviation (SD) of foraminal indices observed in the long bones of lower limb

| | Range | Mean±SD |
|---|---|---|
| Femur | 30.35-64.97 | 46.29±2.46 |
| Tibia | 27.42-37.25 | 32.96±6.06 |
| Fibula | 35.92-68.79 | 39.66±5.29 |

## 4. Discussion

Our present study analyzes the following bone parameters in each:

**Correlation with the length:** The external opening of the nutrient canal, usually referred to as the nutrient foramen [12], has a particular position for each bone. Mysorekar [13] in his study on nutrient foramina long bones found no relation between length and number of foramina of bones which supports the finding in present study. As such no any data is available to confirm that bone length is directly proportional to number of nutrient foramina. For example the maximum length of femur was up to 45-47 cm either it consist of one NF or three. It is also obvious that hormones like Growth hormone, Androgens and Estrogens play a vital role in adolescent age for maintenance of bone growth [14]. Probably the nutrient foramina will remain the same since they are concerned with intraosseous plexuses within the medullary cavity for regeneration of the blood and formation of bone marrow as suggested by Trueta.

**Number of the nutrient foramina**: In the present study 78% femora possessing single dominant nutrient foramina, while 22% bones had double dominant nutrient foramina. That shows the majority of bones have single nutrient foramina which may represent the single source of blood supply. This is in agreement with previous studies reported by Kizilkanat et al [6]. Pereira, G. A. M.; Lopes [15].

In the present study 100% tibiae possessing single dominant nutrient foramina. This is in agreement with previous studies reported by Kulkarni et al [16], Tejaswi H. L [17], and Kizilkanat et al.

In this study, 04% fibulae we did not find any nutrient foramen and 96% presented a single dominant nutrient foramen.Similar data had been reported by Kizilkanat et al., BV Murlimanju, Pereira, G. A. M.; Lopes, P. T. C.; Santos, A. M. P. V. & Silveira, F. H. S.

**Size of Nutrient Foramina:** Our present study shows that about 76% nutrient Foramina of femur were dominant in nature and 24% were secondary. This result is also follows the previous studies.

In the tibiae studied 100% nutrient foramina were dominant in size. This is in agreement with previous studies reported by Kizilkanat et al., BVMurlimanju & Tejaswi H. L.

In this study of fibulae 82.75% foramina were dominant in size and 17.24% were secondary in size. Similar results reported by Kizilkanat et al., BVMurlimanju & Dr. Shamsunder Rao V [18].

## 5. Conclusion

The present study confirms information on the, number, size and position of the nutrient foramina on the lower limb long bones in populations of the Rewa region. There was no significant association between nutrient foramina parameters with bone length. The parameters of the nutrient foramina in the femur, tibia and fibula as reported will be useful to prevent intra operative injuries and poor prognosis during procedures such as vascularised bone grafting, fracture repair, tumour resections and any other orthopaedic interventions among the Rewa region populations.

**Fig 1:** lower limb long bones


**Fig 2 and 3:** Showing using of hand lens and nutrient foramen

**Fig 4:** Measurement of total length of femur

**Fig 5:** Measurement of total length of tibia

**Fig 6:** Measurement of total length of fibula

## References


1. Krishna Garg. Skeleton in Krishna Garg. B.D. Chaurasia – Hand Book of General Anatomy, CBS 5th Ed., 1-370
2. Vishram Singh. Skeleton. In: Shabina Nassim, Goldy Bhatnagar. General Anatomy, Elsevier, A division of Reed Elsevier India private Limited. 2008, 1-263
3. Nagel A. The Clinical Significance of the Nutrient Artery. 1993.
4. Murray Brookes (M.A., D.M.). The Blood Supply of Bone. An Approach to Bone Biology. Division of Anatomy and Cell Biology, United Medical and Dental School, Guy's Hospital, London, UK. London Butter worths. 1971; 1-6.
5. Lewis OJ. From The Department of Anatomy, St Thomas's Hospital Medical School, London. The Blood Supply of Developing Long Bones with Special reference to the Metaphyses. J. Bone Jt. Surg. 1956; 38:928-933.
6. kizilkanata, Neslihanboyana, Esin T. Ozsahina, Roger Soamesb, Ozkanoguza. Location, Number and Clinical Significance of nutrient Foramina in Human Long Bones. Ann. Anat. 2007; 189:87–95.
7. Ukohaukoha Ukoha1, Kosisochukwu Emmanuel Umeasalugo1, Henry C Nzeako1, Damian N Ezejindu1. A Study of the Nutrient Foramina in Long Bones of Nigerians. National Journal of Medical Research. 2013; 3(4):304-307.
8. Murlimanju Bv. Morphological and Topographical Anatomy of Nutrient Foramina in the Lower Limb Long Bones and Its Clinical Importance. The Australasian Medical Journal. 2011; 4(10):530-53.
9. Sammerayassinshaheen. Diaphyseal Nutrient Foramina in Human Upper and Lower Limb Long Bones. King Saud University (Repository.Ksu.Edu.Sa/Jspui/Bitstream/123456789/.../Final%20thesis.Pdf), 2009.
10. Sendemir E, Cimen A. Nutrient Foramina in the Shafts of Lower Limb Long Bones: Situation and Number. Surg. Radiol. Anat. 1991; 13:105-108.
11. Sammera yassin shaheen. Diaphyseal Nutrient Foramina in Human Upper and Lower Limb Long Bones. King Saud University (Repository.Ksu.Edu.Sa/Jspui/Bitstream/123456789/.../Final%20thesis.Pdf), 2009.
12. Malukar O, Hemang Joshi H. Diaphysial Nutrient Foramina in Long Bones and Miniature Long Bones. National Journal of Integrated Research in Medicine (Njirm). 2011; 2(2):23-26.
13. Mysorekar VR. Diaphysial Nutrient Foramina in Human Long Bones. J Anat. 1967; 101:813-822.
14. Kim E. Barrett in Endocrine system, Ganongs Review of Medical Physiology, 24th Edition. McGraw-Hill education.
15. Pereira GAM, Lopes PTC, Santos AMPV, Silveira FHS. 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
16. Chirag R Vadhel, Manoj M Kulkarni, Achleshwar R Gandotra. Anatomy of Nutrient Foramen of tibia- a study from Gujarat region. Indian Journal of Clinical Anatomy and physiology. 2015; 2(1):6-10.
17. Tejaswi HL, Krishnanand Shetty, KR Dakshayani. Anatomic Study of Nutrient Foramina in the Human Tibiae and Their Clinical Importance. International Journal of Recent Trends in Science and Technology. 2014; 9:334-336.
18. Shamsunderrao V, Jyothinathkothapalli. The Diaphyseal Nutrient Foramina Architecture - A Study on the Human Upper and Lower Limb. IOSR Journal of Pharmacy and Biological Sciences (Iosr-Jpbs). Ver. Iii (Jan. 2014), 2014; 9(1):36-4.