# STUDY OF THE NUTRIENT FORAMINA OF DRIED LONG BONES OF THE LEG WITH THEIR CLINICAL IMPLICATIONS

**Munazza Sardar,[1] Maria Ilyas,[2] M. Qasim Muneer,[3] Moeez Akram,[4] M. Zeeshan,[5] Abdullah Farooqi,[6] Mahjabeen Muneera[7]**

## ABSTRACT

**Background and Objective:** The chief source of blood supply for the growing bones is the nutrient artery; which enters the bone shaft through nutrient foramina (NF). The topographical and morphometric study and understanding about the location of NF of bones of the leg is clinically significant during surgical procedures. The purpose of the study was to identify the position of NF in the diaphysis of tibia and fibula, to help prevent any damage to the nutrient artery during bone surgeries.

**Methods:** The study was carried out in the Department of Anatomy, Allama Iqbal Medical College, Lahore, from August 2024 to September 2024. A total of 140 adult dry bones including 70 tibiae and 70 fibulae were taken from the Department of Anatomy, Allama Iqbal Medical College, Lahore. Total length of the bones and the distance of nutrient foramina from the proximal ends were measured and foraminal index (FI) was calculated.

**Results:** Single primary nutrient foramina were observed in all the tibiae and fibulae. There were 39 (55.71%) tibiae of the left and 31 tibiae (44.28%) of the right side. Mean foraminal index of the left tibiae was 32.45± 3.08 cm and that of right was 33.82± 5.89 cm. There were 36 (51.43%) left sided fibulae and 34 (48.57%) right sided. Mean foraminal index of the left fibulae was 47.55± 10.55 cm and that of right was 51.88± 8.29.

**Conclusion:** This study was provided data on number, location and direction of nutrient foramina in long bones. Location may vary but direction remains same. This knowledge will be helpful during different surgical procedures to preserve bone vasculature and increase the success rate.

**Key Words:** Nutrient foramen, Dry tibia, Dry fibula, Foramen index.

**How to cite:** *Sardar M, Ilyas M, Muneer MQ, Akram M, Zeeshan M, Farooqi A, Muneera M. Study of the nutrient foramina of dried long bones of the leg with their clinical implications. JAIMC.2025;23(1):29-32*

Tibia and fibula are long bones of the leg**.** The NF on human long bones form significant landmarks as they serve as a gateway for the blood supply to the bones.[1] These foramina on long bones may vary in position, size and number. The location and direction of the foramen may also vary.[2] Arterial blood to the long bones is provided by various type of arteries including metaphyseal, epiphyseal, periosteal and nutrient arteries; these arteries distribute blood to their respective surfaces.[3] The diaphysis and metaphysis of long bones get their prime arterial supply from the nutrient artery, which passes through larger or smaller openings found in the shafts of these bones. These openings, known as nutrient foramina, lead into the nutrient canal. The nutrient artery passes in this canal through the cortex into the medullary cavity serving as the primary artery of bone tissue.[4] The nutrient artery plays a significant role during embryonic development and phase of active growth, and is essential for the development of the epiphyseal cartilage and diaphysis.[5]

Nutrient arteries supply 70-80% of the

*1-2,7. Department of Anatomy, Allama Iqbal Medical College.*
*3. Department of Anatomy, King Edward Medical University.*
*4-6. House Officer, Jinnah Hospital Lahore.*
**Correspondence:**
Dr. Munazza Safdar, *Associate Professor, Department of Anatomy, Allama Iqbal Medical College. Email: munazza5@yahoo.com*

Submission Date: 08-01-2025
1st Revision Date: 30-01-2025
Acceptance Date: 13-02-2025

nutrition to the growing bones. If this supply is somehow decreased, it leads to ischemia due to decreased vascularization of the growth plate and metaphysis.[6] Understanding bone vasculature is important for performing various surgeries such as bone grafting, fracture fixation, resection of tumour and replacement of knee.[7] The direction and exact position of the NF is important to know, as successful bone surgery is dependent on good vascularity in the bone.[8]

Tibia is one of the most stable bone in our body. Its weight bearing feature helps to maintain bipedal posture and walk with stability[7]. Fibula is a non-weight bearing straight bone[1] and is widely used for implantation of bone grafts and vascularized bone transplants.[8]

The understanding of NF reflects not only for bone vascularization but also helps in diagnosing certain pathological conditions of the bones like fracture healing or any developmental anomalies.[3] The NF of long bones of leg are directed away from the knee and so are the nutrient vessels.[4] The knowledge and information about nutrient foramina has great significance in orthosurgical procedures like bone grafting, repair of fracture, vascularized bone microsurgery and in medicolegal cases.[2] Therefore it is necessary for orthopaedic and microvascular surgeons to have exact understanding about NF before surgery so as to ensure successful and improved prognosis.[9] The purpose of this study was to get information regarding the NF of dried tibia and fibula topographically and morphometrically in local population.

## METHODS

This observational cross-sectional study was conducted in the Department of Anatomy, Allama Iqbal Medical College, Lahore, from August 2024 to September 2024. Approval from the IRB Committee was taken with reference number ERB 169/8/ 21-08-2024/S1 ERB. 140 dry available adult bones of the leg (70 tibiae and 70 fibulae) were taken from the Department. Age and sex were not determined. The damaged bones were excluded from the study. Side determination of the bones was done and only primary nutrient foramina were selected for the study. The foramina were recognized by the presence of a distinct groove with slightly raised margins at its commencement with the help of a magnified lens. To determine the length of the bones, they were placed on the osteometric board individually and the total length was recorded; for measuring the distance of NF, the distance of the foramina from the proximal ends of the bones was noted on the osteometric board (Fig. 1, 2). The foraminal index(FI) was determined by Huges formula[9].

$$FI = (DNF/TL) \times 100$$

where NFD = The distance of the nutrient foramen from the proximal end of the bone

TL = Total length of bone.

Based on the value of FI, NF are categorized into three types.[10]

Type 1: FI value up to 33.33, the NF is in the proximal third of the diaphysis.

Type 2: FI value from 33.33 to 66.66, the NF is in the middle third of the diaphysis.

Type 3: FI value over 66.66, the NF is in the distal third of the diaphysis.

**Figure 1:** *Tibia placed on the osteometric board for morphometry and topography of NF.*

**Figure 2:** *Fibula placed on the osteometric board for morphometry and topography of NF.*

Data were analyzed in SPSS version 26. Mean and standard deviation were calculated for bone length and distance of nutrient foramina from the proximal ends of tibia and fibula and their foraminal index were calculated.

## RESULTS

A total of 140 adult dry bones including 70 tibiae and 70 fibulae were studied for morphometric analysis of diaphyseal nutrient foramina. A single primary NF was observed in all the tibiae and fibulae. There were 39 (55.71%) tibiae of the left and 31 tibiae (44.28%) of the right side. Mean foraminal index of the left tibiae was 32.45± 3.08 cm and that of right tibiae was 33.82± 5.89 cm (Table 1). There were 36 (51.43%) left sided fibulae and 34 (48.57%) right sided. Mean foraminal index of the left fibulae was 47.55± 10.55 cm and that of right fibulae was 51.88± 8.29 (Table 2). Regarding fibulae, 94.44% of the left fibulae and 94.12% of the right fibulae had foramina in the middle 1/3.

*Table 1: Morphometrical analysis of diaphysial nutrient foramen in dry adult tibia.*

| Tibia | Total length (cm) | Distance of NF from proximal end (cm) | Foramen Index |
|---|---|---|---|
| **Left Tibia** | | | |
| **N** | 39 | 39 | 39 |
| **Mean** | 38.24 | 12.41 | 32.45 |
| **Std. Deviation** | 2.28 | 1.35 | 3.08 |
| **Right Tibia** | | | |
| **N** | 31 | 31 | 31 |
| **Mean** | 37.69 | 12.75 | 33.82 |
| **Std. Deviation** | 5.89 | 2.25 | 5.89 |

*Table 2: Morphometricl analysis of diaphysial nutrient foramen in dry adult fibula.*

| Fibula | Total length (cm) | Distance of NF from proximal end (cm) | Foramen Index |
|---|---|---|---|
| **Left Fibula** | | | |
| **N** | 36 | 36 | 36 |
| **Mean** | 36.13 | 17.18 | 47.55 |
| **Std. Deviation** | 2.02 | 3.83 | 10.55 |
| **Right Fibula** | | | |
| **N** | 34 | 34 | 34 |
| **Mean** | 36.08 | 18.72 | 51.88 |
| **Std. Deviation** | 2.27 | 3.32 | 8.29 |

## DISCUSSION

In this study, the mean tibial length of the left tibiae was 38.24 cm and that on the right side was 37.69 cm. Banu and Sakthivel,[11] had reported that the mean length of tibiae was 36.79 ± 2.24 cm in South Indian population. In our study, a single NF, directed downwards was observed in all the tibiae. A single foramen was also found by many others[2,12-14] present on the posterior surface of tibiae.[5,13] In a study Ulkir et al.[7] found that 5 out of 63 tibiae (7.94%) had 2 nutrient foramina. Studies done by some other authors also showed double NF in tibiae.[9,14] In our study, mean distance of the NF from proximal end (NFD) of left tibiae was 12.41 ± 1.35 cm and on right side it was 12.75 ± 2.25 cm. Chavda and Jethva,[5] found these findings as 11.8 ±2.28 cm on the left side and 11.8 ± 1.93cm on the right side. Mean FI in our study was <33.33 in the tibiae of left side indicating that 79.49% of the left tibiae had nutrient foramen in upper third of the shaft; whereas in the right tibiae, mean FI was almost equal and closer to 33.33 indicating that 64.51% of the right tibiae had NF in the upper third of the shaft. Chavda and Jethva,[5] in their study found the presence of NF in the upper third of shaft of 64.28% tibiae while 35.37% of the bones had in the middle third.

In our study, the mean length of fibulae on the left side was 36.13 cm and on the right side it was 36.08 cm. Wazir et al.[8] found in his study that the average length of left fibulae was 34.6±2.3 cm while that in the right fibulae was 34.9±2.2 cm. In another study conducted in West Bengal by Aggarwal et al.[2] the mean length of fibulae was 34.74 cm. In this study we found a single nutrient foramen on the posterior surface of all the fibulae. In a study conducted by Roshini et al.[15] on specimen of fibulae in Indian population, 89% bones had a single foramen, 4.76% had dual and it was absent in 6.34%. Majid et al.[1] reported that 90% of the fibulae had a single nutrient foramen and 4 % had double; in 6%, the NF was not found. In our study, mean distance of the NF from proximal end of left fibulae was 17.18 ± 3.83 cm and on right side it was 18.72 ± 3.32 cm. In a study by Parmar et al.[13] the mean distance of nutrient foramen from the upper end of fibulae was 11.5 ± 8.99 cm. The present study shows that the mean FI on the left sided fibulae was 47.55 cm and 51.88cm on the right sided. Nutrient foramen on fibulae on both sides were present in the middle third of the posterior surface. Findings very close to us were found in a study done by Majid et al.[1] which showed FI of 34.7 cm with nutrient foramen found on the posterior surface (50%) and on the middle third of the fibula 94%. The study was performed on 70 tibiae and 70

fibulae which were available in the department in limited number. Bones available were of unknown age and sex. Studies involving larger number of bones with known age and sex are warrrnted to provide further evidence on subject.

## CONCLUSION

This study provides insights into the number, location, and direction of nutrient foramina in the long bones of leg. The location of NF on the shafts of tibia and fibula may vary; however, direction remains the same. Data regarding the NF of tibiae and fibulae is important for orthopedic surgeons as microvascular bone grafting and fixation of fractures is becoming very popular.

### Ethical Approval

Approval was obtained from IRB Committee of Allama Iqbal Medical and Dental College /JHL vide reference no. ERB169/8/21-08-2024/S1 ERB

**Conflict of Interest:** *None*

**Funding Source:** *None*

### Author's Contribution

| | |
|---|---|
| Conceptualization study design | MS, IM |
| Data Acquisition | MS, AF, MQM |
| Data Analysis/ interpretation | MI, MQM, MA |
| Manuscript drafting | MS, MZ, MM |
| Manuscript review | MS, MM, MZ |

All authors read and approved the final draft.

## REFERENCES

1. Majid H, Ali SMY, Ejaz R, Athar T, Bukhari MH, Shahid S. Study of the anatomical variations in the nutrient foramina of fibula. APMC. 2020;14(1):37–40. DOI: https://doi.org/10.1007/-s00774-024-01568-6
2. Aggarwal P, Roy R, Medda S. Variations in nutrient foramen in the long bones of lower limb. IJCAP. 2022;9(1):35-41. Doi: https://doi.org/10.18231-/j.ijcap.2022.009
3. Anetai H, Kinose S, Sakamoto R, Onodera R, Kato K, Kawasaki Y, et al. Anatomic characterization of the tibial and fibular nutrient arteries in humans. Anat Sci Int. 2021;96(3):378-385. doi: 10.1007/s12565-020-00600-9. Epub 2021 Jan 16. PMID: 33453037.
4. Chelladurai M, Jacinth JS, Senthamizhchelvan A, Subbulakshmi G. A Study on nutrient foramen of radius and its clinical significance. Int J Acad Med Pharm. 2023;5(4):1816-9. DOI: 10.47009/jamp.-2023.5.4.363
5. Chavda HS, Jethva NK. Morphometric study of nutrient foramen of adult human tibia bone. Int J Anat Radiol Surg. 2019;8(2):5-8.
6. Cihan ÖF, Toma S. Morphology and topography of the nutrient foramina in the shoulder girdle and long bones of the upper extremity. Eur J Ther. 2023;29(3):359-369.
7. Ülkir M, Karaçoban L, Günes BE. Morphologic and morphometric evaluation of nutrient foramina of tibia. J Anat Soc India. 2023;72(3):239-45. *DOI:* 10.4103/jasi.jasi_87_22.
8. Wazir NU, Haris M, Baseer N, Haris S, Deeba F, Khan MJ. Morphometrical analysis of diaphyseal nutrient foramina of adult human dry fibulae. Med. Forum . 2022. 33(3):113-5.
9. Prasad S, Sinha SK, Suman S, Hayat SM. A study on morphological features of nutrient foramen of the tibia in human population of South Bihar region. Natl J Clin Anat. 2021;10(1):41-5.
10. Dervisevic L, Dervisevic A, Ajanovic Z, Dervisevic E, Tokic JB, Salihbegovic A, et al. The anatomy and clinical significance of variations of the tibial nutrient foramina – an experimental investigation on dried human bones in a Bosnian population. Rev Rom Anat Funct Clin Macro Microsc Antropol. 2022;21(2). 73-81
11. Banu J, Sakthivel S. Osteometric analysis of human adult dry tibia at a medical college in South India: a cross-sectional study. MRIMS J Health Sci. 2024:10-4103. DOI: 10.4103/mjhs.mjhs_2_24
12. Ghosh T, Ray MK. Anthropometric analysis of nutrient foramen of tibia – a study in eastern India. Int J Res. 2020;7(2):100-3.
13. Ali FB, Tale AK, Ali M, Kulmi M. An anatomical study of the nutrient foramen of adult human tibia. Int J Health Sci. 2022;3:7418-22. DOI: 10.53730/ijhs.v6nS3.7688
14. Suja RS, Alikunju M, Oommen AM, Sreekumar R, Sukumaran SK, Nair CMK et al. Morphology, topography and clinical significance of primary nutrient foramina in tibia. J Evid Based Med Healthc. 2021 ;10(14):999-1003.
15. Roshini N, Yuvaraj MF, Kasirajan SP, Karunakaran B, Govindan L, Caleb JT, Sivalingam AM, Siva T, Kumar S. Nutrient foramina of human fibula: morphometric analysis and clinical relevance. Journal of Bone and Mineral Metabolism. 2025 Mar;43(2):149-57. DOI: https://doi.org/10.1007-/s00774-024-01568-6