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RESEARCH ARTICLE

Morphometric Study of Nutrient Foramina of Fibula

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Abstract

Background: The fibula serves as an important donor bone in reconstructive surgery and plays a vital role in lower limb biomechanics. The nutrient foramen is the entry point for the nutrient artery, essential for medullary blood supply and bone healing. Detailed morphometric analysis of nutrient foramina is clinically significant to avoid vascular compromise during surgical procedures. **Objectives:** To study the number, position, location, and direction of nutrient foramina in the fibula, and to compare findings with previous literature. **Materials:** A total of 50 adult dry human fibulae (25 right, 25 left) of unknown age and sex were examined macroscopically. The number, position, and location of nutrient foramina were recorded, and the foraminal index was calculated. The direction of each foramen relative to the growing end was also noted. Data were tabulated and expressed as percentages. **Results:** Out of 50 fibulae, 42 (84%) had a single nutrient foramen, 5 (10%) had double foramina, and 3 (6%) showed no foramen. The middle third of the shaft contained 90.38% of foramina, with 9.62% in the distal third; no foramina were found in the proximal third. Posterior surface location was most common (94.23%), followed by the lateral surface (5.77%); no foramina were found on the medial surface. All single foramina were directed away from the growing end; among double foramina, 40% had both directed away, and 60% had one directed towards the growing end. **Conclusion:** The fibula most commonly contains a single nutrient foramen in the middle third of the shaft on the posterior surface, directed away from the growing end. This constancy has significant clinical relevance in preserving vascular supply during orthopedic and reconstructive procedures, and the findings provide a useful baseline for anatomical, anthropological, and forensic applications.

Keywords: Fibula, Morphometry, Nutrient Foramen, Orthopaedics Surgery, Vascular Anatomy

1. Introduction

The fibula, the slender lateral bone of the leg, plays a vital role in providing muscle attachments, maintaining ankle stability, and contributing to the overall biomechanics of the lower limb[3]. Although it bears only a small proportion of body weight compared to the tibia, its structural integrity is essential for normal locomotion and for serving as a donor site in various orthopaedic and reconstructive surgical procedures[4,5].

2. Aim and Objectives

To study the number, position, location, and direction of nutrient foramina in the fibula, and to compare findings with previous literature.

3. Review of Literature

The nutrient foramen is a small opening in the cortex of long bones through which the nutrient artery enters to supply the medullary cavity and the inner two-thirds of the cortex[1]. The nutrient artery of the fibula, most commonly a branch of the peroneal artery, is crucial for the bone's growth during development and for its healing after injury[4]. Knowledge of the number, location, direction, and size of nutrient foramina is important for surgeons performing procedures such as fibular graft harvesting, fracture fixation, and tumor resections, where preservation of vascular supply is critical for optimal outcomes[2,6].

Variations in the position and number of nutrient foramina may occur due to genetic, developmental, or

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environmental factors[2,7]. Since the nutrient foramen's location is relatively constant but can vary between populations, morphometric studies provide valuable reference data for anatomists, forensic experts, and orthopaedic surgeons[8,9]. Detailed anatomical knowledge can help avoid iatrogenic injury to the nutrient artery, thus preventing delayed union or non-union of fractures[10].

In recent years, morphometric analysis of nutrient foramina has gained attention not only in clinical orthopaedics but also in anthropology and forensic sciences, where it can assist in skeletal identification and comparative anatomy[8,9]. However, there is limited literature focusing specifically on the fibula, especially within certain population groups[9]. Therefore, region-specific morphometric studies are required to contribute to a comprehensive anatomical database.

4. Material and Methods

4.1 Number of Foramina

Nutrient foramen was identified by the presence of a well-marked groove leading to the foramen with slightly raised edges. Only well-defined foramen of the diaphysis was taken up for this study. The number of foramina in each bone was counted and tabulated.

4.2 Position of the Foramina

Position of a foramen was determined by calculating the Foraminal Index by applying

The Hughes formula[11]
FI = (DNF/FL) X 100 where FI is the Foraminal Index
DNF is the distance of the foramen from the proximal end of the bone
FL is the total length of Fibula

Based on the foraminal index, the position of a foramen may be of three types Type I: FI< 33.33 (Proximal third of shaft of fibula)
Type II: FI 33.33 – 66.66(Middle third of shaft of fibula)
Type III: FI>66.66 (Distal third of shaft of fibula)

4.3 Location of Foramina

Topography of a foramen in relation to specific borders and surfaces was noted

4.4 Direction of Foramina

A needle was passed through the nutrient canal to determine its direction

5. Results (Including Observations)

In the present study, a total of 50 fibulae (25 right and 25 left) were examined for the presence and number of nutrient foramina (Table 1). A single nutrient foramen was observed in 42 specimens (84%), making it the most frequent pattern. Double nutrient foramina (Figure 2) were present in 5 specimens (10%), while 3 fibulae (6%) showed complete absence of a nutrient foramen. When present, the nutrient foramen was more commonly located as a single opening rather than multiple, irrespective of side (Figure 1). The absence of a nutrient foramen, although uncommon, is of clinical importance, as such bones may depend predominantly on periosteal vessels for vascular supply. These findings are comparable with previous studies that report single foramina as the predominant pattern in long bones, with occasional occurrence of double or absent foramina[1,2,7].

In the present series, the nutrient foramen was most commonly located in the middle third of the fibula, accounting for 90.38% of all foramina observed (47 out of 52). The distal third location was noted in only 5 foramina (9.62%). No nutrient foramina were found in the proximal third of any specimen. These findings indicate a marked predilection for the middle third region, consistent with the general rule of ossification in long bones described by Berard[11] where the nutrient foramen is directed away from the growing end (Table 2).

In the present study, the majority of nutrient foramina were located on the posterior surface of the fibula (94.23%), making it the predominant site of entry for the nutrient artery. The lateral surface accounted for only 5.77% of foramina, while no nutrient foramen was observed on the medial surface in any specimen. This

Table 1. Number of foramen

No. of foramen	No. of fibulae		Total	Percentage
	Right	Left		
Single foramen	22	20	42	84 %
Double foramina	2	3	5	10 %
Absent foramen	1	2	3	6 %

Figure 1. Double foramen.

Figure 2. Single foramen

Table 2. Position of foramen

Position of the foramen	No. of fibulae		Total	Percentage
	Right	Left		
Proximal third	0	0	0	0
Middle third	24	23	47	90.38 %
Distal third	2	3	5	9.61%

strong preference for the posterior surface aligns with the anatomical course of the nutrient artery, which typically enters along the posterior aspect (Figure 3) in relation to the interosseous membrane and muscle attachments[8,9] (Table 3).

Figure 3. Foramen on the posterior surface.

Table 3. Location of foramen

Location of foramen	No. of nutrient foramen		Total	Percentage
Posterior surface	R	25	49	94.23 %
	L	24		
Lateral surface	R	1	3	5.77%
	L	2		
Medial surface	R	-	-	-
	L	-		

Direction of the Foramen

In the present study, out of the 42 fibulae that exhibited a single nutrient foramen, all foramina (100%) were directed away from the growing end, consistent with the general rule of ossification in long bones. Among the 5 fibulae with double nutrient foramina, 2 specimens (40%) showed both foramina directed away from the growing end, whereas in the remaining 3 specimens (60%), one foramen was directed away and the other towards the growing end. This variation in direction among double foramina specimens may reflect developmental or vascular pattern differences (Figure 4).

6. Discussion

The present morphometric study of the nutrient foramina of the fibula aimed to document their number,

Figure 4. Direction of the foramen.

position, location, and direction, and to compare these observations with previous anatomical reports. A total of 50 fibulae were examined, yielding a total of 52 nutrient foramina.

6.1 Number of Nutrient Foramina

In the current series, the majority of fibulae (84%) possessed a single nutrient foramen, which agrees with previous studies that have reported single foramina as the predominant pattern in long bones. Mysorekar[1] and Sendemir and Cimen[2] observed a similar trend in Indian and Turkish populations, respectively, with single foramina accounting for over 80% of cases. The presence of double foramina in 10% of specimens and absence in 6% also falls within the variation range reported in earlier studies (5–12% for double foramina and up to 8% for absence). The absence of a nutrient foramen is of particular clinical interest, as such bones rely predominantly on periosteal vessels for nutrition[10], which may influence fracture healing and graft viability.

6.2 Position of the Nutrient Foramina

The present study found that 90.38% of foramina were located in the middle third of the Fibula and only 9.62% in the distal third and none in the proximal third. This strong preference for the middle third is consistent with the general rule of ossification proposed by Berard[11], which states that the nutrient foramen is directed away from the growing end. Similar results were reported by Kizilkanat *et al.*,[6] in a Turkish sample and by Longia *et al.*,[7] in North Indian fibulae, reinforcing the concept of positional constancy of the nutrient foramen in this bone.

6.3 Location of the Nutrient Foramina

The posterior surface was the most common location for the nutrient foramen in this series (94.23%), which aligns with the anatomical pathway of the nutrient artery, most often a branch of the peroneal artery, entering the bone posteriorly in relation to the interosseous membrane. Only 5.77% of foramina were located on the lateral surface, while none were found on the medial surface. This is consistent with the findings of Pereira *et al.,* and Gupta *et al.*[8,9], who also reported a marked dominance of posterior surface entry in their morphometric analyses.

6.4 Direction of the Nutrient Foramina

In all fibulae with a single nutrient foramen, the direction was away from the growing end (i.e., towards the proximal end in the fibula), supporting the ossification rule. However, in specimens with double foramina, variation was observed — in 60% of these cases, one foramen was directed towards the growing end, possibly representing a secondary or accessory vascular channel formed during development[6,8]. Such variations may have clinical significance in surgical approaches to the fibula, as they could affect intraosseous blood supply patterns.

6.5 Clinical and Surgical Implications

Knowledge of the morphometry of nutrient foramina is crucial in orthopaedic and reconstructive procedures involving the fibula, such as free vascularized fibular grafts, fracture fixation, and tumor resection. Preserving the nutrient artery is essential to maintain intramedullary blood supply and promote optimal bone healing. Misidentification or injury to the artery during surgical dissection could increase the risk of delayed union or non-union[4,10]. In forensic anthropology, these morphometric patterns may also assist in skeletal identification, particularly in population-specific contexts[8,9].

7. Summary and Conclusion

In the present morphometric study of 50 fibulae, the majority (84%) exhibited a single nutrient foramen,

most commonly located in the middle third of the shaft (90.38%) and on the posterior surface (94.23%). All single foramina and most double foramina were directed away from the growing end, in accordance with the general ossification rule. These findings are consistent with previous reports and reinforce the relative constancy of nutrient foramen morphology in the fibula. Awareness of these anatomical features is essential for orthopaedic and reconstructive surgeons to preserve vascular supply during procedures such as fibular grafting and fracture fixation, thereby promoting optimal healing outcomes. Additionally, the data may serve as a valuable reference for anthropological and forensic investigations.

8. References

1. Mysorekar VR. Diaphysial nutrient foramina in human long bones. J Anat. 1967; 101(Pt 4):813-22.
2. Sendemir E, Cimen A. Nutrient foramina in the shafts of lower limb long bones: situation and number. Surg Radiol Anat. 1991; 13(2):105-8. https://doi.org/10.1007/BF01623881 PMid:1925909.
3. Standring S, editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. London: Elsevier; 2020.
4. Choi SW, Kim HJ, Koh KS, Chung IH. Topographical anatomy of the fibula and peroneal artery in adults and its clinical implications. Clin Anat. 2001; 14(5):371-7.
5. Choi SW, Kim HJ, Koh KS, Chung IH. The cutaneous perforators of the peroneal artery in the distal leg. Plast Reconstr Surg. 2001; 108(3):793-7.
6. Kizilkanat E, Boyan N, Ozsahin ET, Soames R, Oguz O. Location, number and clinical significance of nutrient foramina in human long bones. Ann Anat. 2007; 189(1):87-95. https://doi.org/10.1016/j.aanat.2006.07.004 PMid:17319614.
7. Longia GS, Ajmani ML, Saxena SK, Thomas RJ. Study of diaphysial nutrient foramina in human long bones. Acta Anat (Basel). 1980; 107(4):399-406. https://doi.org/10.1159/000145267 PMid:7405528.
8. 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):514-20. https://doi.org/10.4067/S0717-95022011000200035
9. Gupta R, Soni P, Singh D, Kumar R, Mahajan A. Morphometric study of nutrient foramina in lower limb long bones. Int J Res Med Sci. 2017; 5(5):2049-52.
10. Dwek JR. The periosteum: what is it, where is it, and what mimics it in its absence? Skeletal Radiol. 2010; 39(4):319-23. https://doi.org/10.1007/s00256-009-0849-9 PMid:20049593 PMCid:PMC2826636.
11. Berard A. Memoire sur les foramens nutritifs des os longs. J Anat Physiol. 1835; 2:3-14.