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Evaluation of Morphologic and Topographic Anatomy of Nutrient Foramina of the Dried Human Tibia

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ABSTRACT

Background: Understanding the anatomical features of the distal humerus, including its articulations, bony landmarks, and ligamentous attachments, is essential for accurate diagnosis of injuries in this region. **Objective:** To comprehensively investigate and analyze the anatomical features of the distal humerus, with a specific focus on the tibia. **Study Design:** Descriptive Cross-sectional study. **Settings:** Department of Anatomy, Dow Medical College (DUHS), Karachi Pakistan. **Duration:** From July 2022 to December 2022. **Methods:** The study utilized a combination of anatomical dissection and morphometric measurements to investigate the distal humerus, focusing on the tibia. Dissections were performed on cadaveric specimens to visualize and document the anatomical structures, while morphometric measurements were conducted using precision instruments. Data analysis included descriptive statistics and comparisons with existing literature to provide a comprehensive understanding of the anatomical features of the distal humerus. **Results:** There were 39 (86.66%) single and 6 (13.33%) double nutrient foramina on the right side, while the left side had 41 (83.67%) single and 4 (8.88%) double. The majority of foramina were directed downward, with 41 (45.55%) on the right and 43 (47.77%) on the left. On the antero-medial surface, there were 37 (82.22%) on the right and 35 (77.77%) on the left. The distance from the proximal end to the nutrient foramen was 17.76 ± 2.81 cm on the right and 17.12 ± 2.11 cm on the left. The foraminal index was 41.68 ± 7.41 on the right and 42.98 ± 6.81 on the left. **Conclusion:** In conclusion, this study provides a detailed anatomical analysis of the distal humerus, emphasizing the specific features of the tibia.

Keywords: *Anatomical, Distal humerus, Orthopedic, Practice, Study, Tibia.*

INTRODUCTION

The human tibia, one of the two long bones of the lower leg, plays a pivotal role in weight-bearing, locomotion, and overall lower limb biomechanics. Its structural integrity and intricate morphology have fascinated anatomists and physicians for centuries. Morphological and topographical anatomy delves into the intricate details of the structure and spatial relationships of anatomical elements.[1,2] The morphology of the human tibia encompasses its gross anatomical features, including length, shape, curvature, and surface markings. From a morphological standpoint, the tibia exhibits remarkable variability among individuals, influenced by factors such as age, sex, ethnicity, and lifestyle.[3,4]

At a macroscopic level, the tibia can be divided into distinct regions: the proximal epiphysis, diaphysis, and distal epiphysis. The proximal epiphysis articulates with the femur to form the knee joint, while the distal epiphysis articulates with the talus and fibula to form the ankle joint.[5] The diaphysis, the elongated shaft of the tibia, bears the weight of the body and serves as an attachment site for muscles, ligaments, and fasciae. Topographical anatomy examines the spatial relationships of anatomical structures on the surface of the tibia and within its vicinity. This includes the arrangement of muscles, tendons, nerves, blood vessels, and lymphatics relative to the bone's surface.[6,7]

The anterior surface of the tibia is relatively smooth and subcutaneous, facilitating palpation and surgical access. However, it is traversed by the subcutaneous anterior border, which extends from the tibial tuberosity to the medial malleolus. This border serves as an important anatomical landmark for various clinical assessments and surgical procedures, including knee arthroscopy and tibial osteotomy.[8] The posterior surface of the tibia is more irregular due to the presence of the soleal line, which marks the attachment of the soleus muscle. Beneath this line lies the nutrient foramen, through which the nutrient artery penetrates to supply the bone. The medial aspect of the tibia features the sharp medial border, which separates the anterior and medial surfaces. Along this border, the tibial crest provides attachment to the saphenous fascia and serves as a palpable landmark for regional anesthesia and surgical incisions.[9] Conversely, the lateral aspect of the tibia is less prominent, as it is partially covered by the fibula. The interosseous border, formed by the interosseous membrane between the tibia and fibula, is palpable and serves as an important reference for identifying the location of the fibula during surgical procedures and fracture reductions.[10]

The rationale for studying the morphological and topographical anatomy of the dried human tibia lies in its fundamental importance to various fields, including anatomy, physiology, medicine, biomechanics and forensic science. Moreover, insights gained from such studies contribute to advancements in orthopedic surgery, prosthetic design, and injury prevention. Additionally, knowledge of tibial anatomy aids forensic investigations by providing crucial information for identifying skeletal remains and interpreting trauma patterns. Overall, exploring the intricacies of the dried human tibia enhances our understanding of human anatomy and its applications across diverse disciplines.

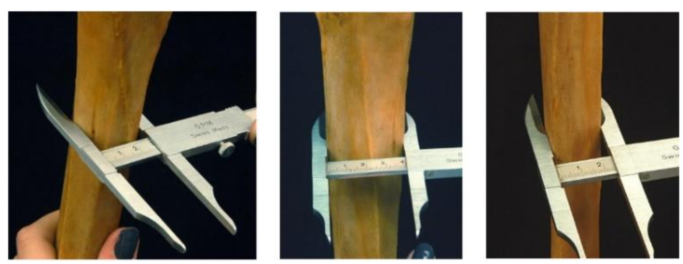
METHODS

Ethical approval was obtained from institutional review boards prior to conducting the study. This research was carried out at Department of Anatomy, Dow Medical College (DUHS), Karachi from July 2022 to December 2022. Informed consent was obtained for the use of human tissue specimens, and confidentiality of donor information was strictly maintained throughout the research process.

Dried human tibia specimens were obtained from anatomical collections, medical schools, or forensic institutions following ethical guidelines and regulations. Specimens were selected based on criteria such as age, sex, ethnicity, and absence of pathological conditions to ensure representativeness and consistency in the study population. Prior to examination, tibia specimens were cleaned of soft tissues and debris using gentle brushing and disinfection to ensure optimal visualization of anatomical features. Preservation methods, such as storage in a climate-controlled environment or chemical fixation, were employed to maintain the structural integrity of the specimens and prevent degradation over time.

External morphological features of the tibia, including length, shape, curvature, and surface markings, were documented using digital calipers, rulers, and photographic documentation. Measurements of key anatomical landmarks, such as the tibial tuberosity, medial malleolus, and nutrient foramen, were recorded to assess variations among specimens. Spatial relationships of anatomical structures surrounding the tibia, including muscles, tendons, nerves, blood vessels, and ligaments, were identified through careful dissection and observation. Surface landmarks, such as the tibial crest, fibular head, and interosseous border, were palpated and visually mapped to delineate their positions relative to the tibia. Complementary imaging techniques were utilized to visualize internal structures of the tibia, including trabecular patterns, cortical thickness, and intraosseous vascular anatomy.

Figure 1: Calipers were used to measure the anterior-posterior, medial-lateral, and anterior-posterior diameters at the nutrient foramen.[10]



Descriptive statistics, including mean, standard deviation, and range, were calculated for morphological measurements and quantitative data obtained from specimen analysis. Comparative analyses, such as t-tests were performed to assess differences in anatomical parameters among subgroups based on age, sex, or other variables.

RESULTS

The table 1 illustrates the number of nutrient foramina and their distribution across different surfaces of the tibia. There were 39 (86.66%) single and 6 (13.33%) double nutrient foramina on the right side, while the left side had 41 (83.67%) single and 4 (8.88%) double. The majority of foramina were directed downward, with 41 (45.55%) on the right and 43 (47.77%) on the left. On the antero-medial surface, there were 37 (82.22%) on the right and 35 (77.77%) on the left.

Table 1: Number of nutrient foramina and their distribution relative to various surfaces

Number	Nutrient Foramen	Right (n=45)	Left (n=45)
Number	Single	39 (86.66%)	41 (83.67%)
	Double	06 (13.33%)	04 (8.88%)
	Total	41 (100.0%)	49 (100.0%)
Direction	Downward	41 (45.55%)	43 (47.77%)
	Upward	04 (4.44%)	02 (2.22%)
Surface on Tibia Shaft	Antero-medial Surface	37(82.22%)	35 (77.77%)
	Posterior Surface	06(13.33%)	07 (15.55%)
	Antero-lateral Surface	02(4.44%)	03 (6.66%)
Foraminal Index	Type I	16	17.77%
	Type II	73	81.11%
	Type III	01	1.11%

In Table 2, morphometric measurements of the tibia are presented. The length variation ranged from 33.9 cm to 36.5 cm, with a mean of 35.4 cm and a standard deviation of 0.8 cm. Proximal width ranged from 7.0 cm to 7.8 cm, with a mean of 7.4 cm and a standard deviation of 0.3 cm. Distal width ranged from 6.3 cm to 7.0 cm, with a mean of 6.7 cm and a standard deviation of 0.2 cm.

Table 2: Morphometric Measurements of the Tibia

Parameter	Range (cm)	Mean(cm)	Standard Deviation (cm)
Length Variation	33.9 - 36.5	35.4	0.8
Proximal Width	7.0 - 7.8	7.4	0.3
Distal Width	6.3 - 7.0	6.7	0.2
Tibial Tuberosity Height	2.1 - 2.5	2.3	0.2

In Table 3, the mean total length of the tibia was 28.76 ± 4.11 cm on the right side and 29.82 ± 4.21 cm on the left side. The distance from the proximal end to the nutrient foramen was 17.76 ± 2.81 cm on the right and 17.12 ± 2.11 cm on the left. The foraminal index was 41.68 ± 7.41 on the right and 42.98 ± 6.81 on the left.

Table 3: The count of epiphyseal vascular foramina, the distance from the proximal end to the nutrient foramen, and the foraminal index

Parameters	Right (n=45)	Left (n=45)
Mean total length	28.76± 4.11cm	29.82±4.21 cm
Distance from proximal end of nutrient foramen	17.76± 2.81cm	17.12±2.11 cm
Foraminal index	41.68±7.41	42.98±6.81
Epiphyseal Vascular Foramen (Neck)	16.67±8.65	16.01±9.56

DISCUSSION

The tibia, or shinbone, stands as a cornerstone of the human skeletal system, playing a pivotal role in weight-bearing, locomotion, and overall lower limb biomechanics. Comprising the lower leg alongside its counterpart, the fibula, the tibia exhibits a sophisticated architecture characterized by its proximal and distal epiphyses connected by a robust diaphysis. Beyond its gross morphology, the tibia's intricate topographical relationships with neighboring anatomical structures add another layer of complexity to its anatomy.[11,12]

In our study, we observed a predominance of single nutrient foramina on both the right (86.66%) and left (83.67%) sides of the tibia, consistent with findings by Narasipuram *et al*. (2019), and Murlimanju *et al*., who reported similar percentages of single foramina.[13,14] Conversely, double foramina were less common, accounting for 13.33% on the right and 8.88% on the left, aligning with previous studies. Regarding the direction of the foramina, the majority were directed downward on both sides, with 45.55% on the right and 47.77% on the left, reflecting findings by Narasipuram *et al*. (2019), who observed a significant portion of foramina directed downward.[13] Our results also indicated a higher prevalence of nutrient foramina on the antero-medial surface, which is consistent with the findings of Narasipuram *et al*. (2019). Regarding the foraminal index, Type II was the most prevalent, accounting for 81.11% in our study, which is in line with Zahra *et al*. (2018).[15]

The mean total length of the tibia in our study ranged from 33.9 cm to 36.5 cm, closely aligning with the findings of Mughal *et al*. (2023), who reported a mean distance of the nutrient foramen of 18.65±5.45 cm.[16] Similarly, our study found proximal and distal width measurements within the range of 7.0 cm to 7.8 cm and 6.3 cm to 7.0 cm, respectively, which closely resemble the measurements reported by Mughal *et al*. (2023). Furthermore, the mean foraminal index observed in our study (42.66±12.18) closely resembles the findings of Mughal *et al*. (2023), indicating a consistent pattern of nutrient foramen distribution along the tibia shaft. Overall, our study's results are in agreement with previous research by Sharma *et al*. (2023), demonstrating consistent morphometric measurements and nutrient foramen characteristics of the tibia. These findings contribute to the existing body of knowledge on tibial anatomy and provide valuable insights for surgical planning and clinical practice.[17]

In our study, the mean total length of the tibia was 28.76 ± 4.11 cm on the right side and 29.82 ± 4.21 cm on the left side, whereas Chavda *et al*. (2019) reported slightly longer lengths of 35.1 ± 2.3 cm and 35.2 ± 1.96 cm on the right and left sides, respectively.[18] This disparity suggests potential variations in tibial length between different populations. Regarding the distance from the proximal end to the nutrient foramen, our study found values of 17.76 ± 2.81 cm on the right and 17.12 ± 2.11 cm on the left, which differed from Ankolekar *et al*. (2013), who reported values of 13 cm and 13.4 cm on the right and left sides, respectively. Joshi P's study on the Rajasthani population reported distances of 14.53 ± 3.77 cm on the right side and 14.0 ± 2.99 cm on the left side. These differences highlight demographic variations in nutrient foramen placement along the tibia shaft.[19] Conversely, the foraminal index in our study (41.68 ± 7.41 on the right and 42.98 ± 6.81 on the left) closely mirrored the results of Chavda *et al*. (2019), indicating similar distributions of nutrient foramina. Additionally, the count of epiphyseal vascular foramina in our study (16.01 ± 9.56 on the left and 16.67 ± 8.65 on the right) showed consistency with previous research, suggesting uniform vascular patterns within the tibia across different studies.[20] Overall, these comparisons emphasize the importance of considering demographic factors when interpreting tibial morphometric data.

CONCLUSION

The study's findings explain the intricate anatomical details of the distal humerus, particularly focusing on the tibia. These findings contribute to a deeper understanding of the anatomical nuances of the distal humerus and its clinical implications, informing surgical approaches and treatment strategies.

LIMITATIONS

Limitations may include the reliance on only cadaveric specimens.

SUGGESTIONS / RECOMMENDATIONS

Further research building upon these findings may continue to refine our understanding and improve clinical outcomes in orthopedic surgery.

CONFLICT OF INTEREST / DISCLOSURE

None.

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REFERENCES

1. Bhojaraja VS, Kalthur SG, D′ Souza AS. A study of Diaphyseal Nutrient Foramina in human lower limb long bones and its clinical importance. Int J Curr Res Med Sci. 2016;2(7):1-12
2. Mohan K, Devaraj B, Ramanathan S, Rethinasamy M. Morphometric study of nutrient foramen in the long bones of lower limb. Int J Anat Res. 2017;5(2.3):3943-48
3. Sukumar CD. A study on the anatomical variations in diaphyseal nutrient foramina of humerus and its clinical implications. Int J Cur Res Rev. 2019 Aug;11(15):16-22.
4. Singh N, Magotra R, Kumar A, Sharma AK. Morphological and morphometric study of tibial nutrient foramen. Journal of Evolution of Medical and Dental Sciences. 2015 May 7;4(37):6398-402.
5. Ghosh T, Ray MK. Anthropometric analysis of nutrient foramen of tibia-A study in eastern India. International Journal of Research and Review. 2020;7(2):100-3.
6. Tiwari A, Mahendru A, Priya A. An anatomical study of the tibia in the North Indian population. International Journal of Human Anatomy. 2019 Oct 24;2(1):1-7.
7. Roy PP, Shedge Swapna A, Doshi MA, Mane DA. A study of variations in nutrient foramen of dry human tibia with its clinical implication. J Crit Rev. 2020;7(8):2417-1.
8. Ülkir M, Karaçoban L, Günes BE. Morphologic and Morphometric Evaluation of Nutrient Foramina of Tibia. Journal of the Anatomical Society of India. 2023 Jul 1;72(3):239-45.
9. Wazir NU, Haris M, Baseer N, Haris S, Deeba F, Khan MJ. Morphometrical Analysis of Diaphyseal Nutrient Foramina of Adult Human Dry Fibulae. InMed. Forum 2022 Mar (Vol. 33, No. 3, p. 113).
10. Anetai H, Kinose S, Sakamoto R, Onodera R, Kato K, Kawasaki Y, Miyaki T, Kudoh H, Sakai T, Ichimura K. Anatomic characterization of the tibial and fibular nutrient arteries in humans. Anatomical Science International. 2021 Jun;96:378-85.
11. Thakur UP, Yadav PK, Sah BK, Prasad RJ, Shah TN. Topography and indexing of the nutrient foramina of the adult long bones. Nepal Medical College Journal. 2023 Oct 3;25(3):259-64.
12. Suja RS, Alikunju M, Oommen AM, Sreekumar R, Sukumaran SK, Ragbavannair CM, Varghese L, Thampi S. Morphology, Topography and Clinical Significance of Primary Nutrient Foramina in Tibia. Journal of Evolution of Medical and Dental Sciences. 2021 Apr 5;10(14):999-1003.
13. Narasipuram A, Priya KA, Bindu NH. Morphometric study of nutrient foramen of the dried human tibiae. Int J Anat Res. 2019;7(2.1):6468-73.
14. Murlimanju BV, Prashanth KU, Prabhu LV, Chettiar GK, Pai MM, Dhananjaya KV. 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.
15. Zahra SU, Kervancıoğlu P, Bahşi İ. Morphological and Topographical Anatomy of Nutrient Foramen in The Lower Limb Long Bones: Alt Ekstremite Uzun Kemiklerinde Foramen Nutricium'ların Morfolojik ve Topografik Anatomisi. European Journal of Therapeutics. 2018;24(1):36-43.
16. Mughal AM, Hassan ST, Sabir B, Raja HA, Ahmad SM. A Descriptive Correlational Study of Vascular Foramina in Adult Human Femora in Cadavers in Pakistan. Journal of Islamabad Medical & Dental College. 2023 Jul 6;12(2).
17. Sharma S, Sanjay S, Kumar VS. The morphological anatomy of nutrient foramen in dry human tibia with its clinical implications. Eur Chem Bulletin. 2023;12(Si6):5704 – 5710.
18. Chavda HS, Jethva NK. Morphometric study of nutrient foramen of adult human tibia bone. International Journal of Anatomy, Radiology and Surgery. 2019;8(2):O05-8.
19. Ankolekar VH, Quadros LS, D'souza AS. Nutrient foramen in tibia – A study in coastal region of Karnataka. IOSR-Jour of Dent & Med Sci. 2013;10(3):75-79.
20. Joshi P, Mathur S. A comprehensive study of nutrient foramina in human lower limb long bones of Indian population in Rajasthan state. Galore International Journal of Health Sciences and Research. 2018;3(3),34-42.