ORIGINAL ARTICLE

DIAPHYSEAL NUTRIENT FORAMINA IN DRIED HUMAN ADULT LONG BONES OF LOWER LIMB IN PAKISTAN

Ejaz Afzal, Fatima Sherin, Omair Khan*, Noaman Hussain Siddiqui**

Department of Anatomy, *Department of Forensic Medicine, **Department of Pathology, Ayub Medical College, Abbottabad-Pakistan

Background: osteogenesis needs circulation of blood in the bones. Bone growth, repair of fracture, maintenance of bone vitality and other injures also need blood circulation in proper way. Blood is allowed to flow via holes in the diaphysis, which are called as nutrient foramina. **Methods:** The cross-sectional study was done in the department of Anatomy, Ayub and Khyber Medical College (Osteology Sections). The aim was to observe diaphyseal nutrient foramina in the human long bones of the lower limb. The study was done on 90 long bones of lower limb consisting of 30 femora, 30 tibiae and 30 fibulae. Of all these bones, sex was not determined. All the bones were macroscopically observed. For the number of the foramina, simple counting was done. The foraminae 1 mm away from the borders were counted. All positions were seen macroscopically. For direction and obliquity, stiff wire was used. **Results:** We studied 90 long bones of lower limb. About 80% of long bones of lower limb showed single nutrient foramina. About 18% of lower limb long bones showed two nutrient foraminae. In cases of femora nutrient foraminae were directed proximally. In cases of fibulae and tibiae most of the foramina were directed distally. **Conclusion:** the study has provided additional information on the foramina index, morphology and topography of the nutrient foramina. In the lower limb long bones, the anatomical data is important for the clinicians as the micro-vascular bone transfer is becoming popular. This morphological data can be used by the forensic experts in identification through different landmarks in bones development giving an aid in medicolegal work.

Keywords: Micro-vascular bone transfer; Topography; Femora; Tibiae; Proximally; Distally; Osteology; Diaphysis

J Ayub Med Coll Abbottabad 2017;29(4):623–5

INTRODUCTION

Skeleton of the human body consists of 213 bones, not including the sesamoid bones. Axial skeleton consists of 74 bones, appendicular skeleton consists of 126 bones. Ear bones are six in number.[1]

The circulation of blood is necessary for the osteogenesis, maintenance of bone growth, bone vitality and repair of fracture and other injuries.[2] Long bones get their blood supply by three types of vessels. All these vessels anastomose with one another. Blood supply to cortex is done by nutrient artery (10%). 90% of the supply to bone marrow is done also by nutrient artery. The nutrient artery divides into descending and ascending branches after it gets inside diaphysis.[3,4]

Marrow Space is surrounded by dense and solid cortical bone. The bone marrow cavity is lined by a honey comb arrangement of trabecular bone consists of plates and rods of tabecular bone.[5] The bone resorbing is done by the osteoclast cells. The precursor cells of the monocyte –macrophage system.[6,7]

Long bones of the lower limb in their shafts have holes which are called nutrient foramina. These foramina lead into nutrient canals. Through these canals blood supply is provided to the diaphysis of the long bones. These canals are also present in the irregular bones. Direction of the nutrient foramina is calculated by the growing end of the bones which grows at a faster pace as compared to the non-growing end. The nutrient vessels move away from the growing end.[8,9] It is very important to preserve Nutrient blood supply in bone grafts in order to promote fracture healing.[10] Position of fractures is important in relation to nutrient foramina and healing especially in relation to nailing procedures in long.[11,12]

This morphological information regarding nutrient foramen location in adult long bones is also important for bones identification in skeletal remains where identification of individual can be made from skeletal remains.[13,14]

MATERIAL AND METHODS

The cross-sectional study in the department of Anatomy, Ayub and Khyber Medical College (Osteology Sections) was done with the due permissions from the heads of the departments. The aim was to observe diaphyseal nutrient foramina in the human long bones of the lower limb. The study was done on 90 long bones of lower limb consisting of 30 femora, 30 tibiae and 30 fibulae. Of all these bones, sex was not determined. All the bones were macroscopically observed. For the number of the foraminae, simple counting was done. The foraminae 1 mm away from the borders were counted. All positions were seen macroscopically. For direction and obliquity, stiff wire was used

RESULTS

Of all the fibulae (30) that were examined. 81.25% had one nutrient foramina. Among them, 77.1% nutrient foramina were directed distally. Only 22.2% were directed proximally. Similarly, 46.6% of the femora had one nutrient foramina. 53.4% had two nutrient foramina. All the foramina were directed distally. In all the tibiae, there was only one nutrient foramina. All nutrient foramina were directed distally.

Table-1: Number of diaphyseal nutrient foramina seen in long bones of lower limb

Bone	Number of bone	Number of Foramina	Percentage
Femur (n=30)	14	1	46.6
	16	2	53.4
Tibia (n=30)	30	1	100
Fibula (n=30)	26	1	81.29
	4	2	18.75

Table-2: Direction and position of diaphyseal nutrient foramina in long bones of lower limb

Bone	Position			Direction of Foramina
	Type-1	Type-2	Type-3	
Femur	10 (20.8%)	38 (79.16%)	-	Proximally
Tibia	25 (83.3%)	5 (16.6%)	-	Distally
Fibula	-	35 (97.2%)	1(2.7%)	28 Distally 8 Proximally

DISCUSSION

Nutrient foramina or nutrient canal has a particular position for each long bone of lower limb.[15] It is directed towards the upper end of femur and lower ends of tibia and fibula.

In the present study, we studied 30 femora. Single nutrient foramina were observed in 46.6%, 53.4% showed double nutrient foramina. Previous studies by Kizel Kanat *et al* showed that majority of the femora had single nutrient foramina. They also observed three foraminae in some femora Collipal.[16,17] We did not find that. They also observed up to six nutrient foramina in some femurs, Sendemir and Scimen. Some studies by Gumusburn *et al* and Motabagani showed no nutrient foramina in some femurs, we did not observe that. The present study showed single foramina in all the tibii. It is in accordance with the previous studies. 81.29% of fibulae had one nutrient foramina while 18.7% of the fibulae had two nutrient forminae.[18,19] In some previous studies by Campos *et al* they observed that almost all the fibula had single nutrient foramina.[20]

In cases of femora all the nutrient forminae were directed proximally. In previous studies 0.5–1% nutrient foramina were directed distally. Our study on tibia was matching with the previous studies. Similarly, we matched with the previous study on fibulae that the nutrient foramina were directed towards the lower end.

CONCLUSION

Through our study we confirmed the previous results of number of foramina and direction of nutrient foramina (nutrient canal) in the long bones of lower limb. This study also provided us some useful information regarding the nutrient foraminae which can be used by clinicians specially the orthopaedic surgeons to avoid damage to the nutrient vessels supplying the long bones of the lower limb.

This information is an aid in forensic medicolegal work of human in skeletal remains identification in Mass disasters and another human skeleton discovery.

AUTHOR'S CONTRIBUTION

EA, FS, OK: Concept and design. Collection and assembly of data. NS: Interpretation of data,

REFERENCES

1. Musculoskeletal system. In: Gray's Anatomy, 39th Ed. edited by Standring S, New York, Elsevier; 2004. p83–135
2. Olszta MJ, Cheng X, Jee SS, Kumar R, Kim YY, Kaufman MJ, *et al*. Bone structure and formation: a new perspective. Mater Sci Eng R Rep 2007;58(3):77–116.
3. Beier F. Cell Cycle control and the cartilage growth plate. J Cell Physiol 2005;202(1):1–8
4. Schiessel A. Zweymuller K. The nutrient artery canal of the femur: a radiological study in patients with primary total hip replacement. Skeletal Radial 2004;33(3):142–9.
5. Kobayashi S, Takashi HE, Ito A, Saito N, Nawata M, Horiuchi H, *et al*. Trabecular minimodeling in human iliac bone. Bone 2003;32(2):163–9
6. Lindsay R, Cosmen F, Zhou H, Bostrom MP, Shen VW, Cruz JD, *et al*. A novel tetracycline labelling schedule for longitudinal evaluation of the short-term effects of anabolic therapy with a single iliac crest biopsy: Early actions of teriparatide. J. Bone Miner Res 2006;21(3):366–73.
7. Xing L, Boyce BF. Regulation of apoptosis in osteoclasts and osteoblastic cells. Biochems Biophys Res Commun 2005;328(3):709–20.
8. Al-Motabagani. The arterial architecture of the human femoral diaphysis. J Anat Soc India 2002;51(1):27–31.
9. Anderson HC. Matrix vesicles and calcification. Curr Rheumatol Rep 2003;5(3):222–6.
10. Gumusburun E, Yucel F, Ozkan Y, Akgun Z. A study of the nutrient foramina of lower limb long bones. Surg Radiol Anat 1994;16(4):409–12.
11. 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. Cell Tissues Organs 1950;9(1-2):57–68.
12. Patake SM, Mysorekar VR. Diaphyseal nutrient foramina in human metacarpals and metatarsals. J Anat 1977;124(Pt 2):299–304.
13. Nancy E, Tatarek, Dorothy E. Forensically Significant Skeletal Anatomy. Forensic Radiology 2016. [Internet]. [cited 2017 May 15]. Available from: https://www.barnardhealth.us/forensic-radiology/forensically-significant-skeletal-anatomy.html
14. Bilodi AKS, Reddy BS. A study on nutrient foramina of fibula, its medicolegal aspect and clinical importance in dentistry. World J Pharm Pharm Sci 2014;3(2):2133–44.

15. Collipal E, Vargas R, Parra X, Silva H, Del Sol M. Diaphyseal nutrient foramina in the femur, tibia and fibula bones/Foramenes nutricios diafisarios de los huesos femur, tibia y fibula. Int J Morphol 2007;25(2):305–9.
16. Craig JG, Widman D, van Holsbeeck M. Longitudinal stress fracture: patterns of edema and the importance of the nutrient foramen. Skeletal Radiol 2003;32(1):22–7.
17. Kizilkanata E, Boyana N, Ozsahina ET, Soamesb R, Oguza O. Location, number and clinical significance of nutrient foramina in human long bones. Ann Anat 2007;189(1):87–95.
18. Giustina A, Mazziotti G, Canalis E. Growth hormone insulin like growth factors and the skeleton. Endocr Rev 2008;29(5):535–95.
19. Gotzen N, Cross AR, Ifju PG, Rapoff AJ. Understanding stress concentration about a nutrient foramen. J Biomech 2003;36(10):1511–21.
20. Grabowski P. Physiology of bone. In: Calcium and Bone Disorders in Children and Adolescents. Karger Publishers; 2009. p.32–48.

Received: 16 February, 2017	*Revised:1 June, 2017*	*Accepted:3 June, 2017*

Address for Correspondence:

Dr. Ejaz Afzal, House No. 463, Makkah Street, Habibullah Colony, Abbottabad-Pakistan

Cell: +92 333 502 3727

Email: drejazafzal@yahoo.com