ORIGINAL RESEARCH PAPER

Anatomy

"Observation of Morphology and Topography of Diaphyseal Nutrient Foramen in Tibia"

KEY WORDS: NF, Tibia, Diaphyseal NF, Posterior surface.

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ABSTRACT

Background: Nutrient Foramen is an opening into bone shaft which allows passage of blood vessels and peripheral nerves to the medullary cavity of a bone through bone cortex.

Material and methods: The study was conducted in Department of Anatomy, T. S. Misra Medical College & Hospital, Lucknow. A total of 50 adult human cleaned and dried tibia were examined irrespective of side & sex. Materials used in present study were- Magnifying lens, Bone osteometer, metallic measuring scale, guide wire, 24 hypodermic needle, digital camera for illustration, digital caliper.

Results: In present study, we observed that the Foramen index was ranging from 29.3 – 41.8.

Conclusions: Majority of the primary diaphyseal nutrient foramina of tibia are located on the posterior surface. In the tibia majority of the foramina are in the upper third on the posterior surface.

Introduction:

Nutrient Foramen is an opening into bone shaft which allows passage of blood vessels and peripheral nerves to the medullary cavity of a bone through bone cortex.[1] Nutrient artery is the principal source of blood (80%) to a long bone mainly during the growing period & during the early phases of ossification.[2-6] In the absence of Nutrient Artery, periosteal vessels are the main source of blood supply.[7] The nutrient artery of tibia is a branch of Posterior Tibial Artery. The direction of Nutrient Foramen is determined by the growing end of bone and in majority of cases it is pointed away from growing end.[8] Their direction is usually described by the jingle "To the elbow I go, from the knee I flee". The location and number of Nutrient Foramen is a non- constant feature in long bones.[9] Longitudinal stress fractures are relatively more common in tibia as compared to other long bones.[10] These fractures initiate either from Nutrient Foramen or from superomedial aspect.[11] It is usually accompanied by rupture of Nutrient Artery which starts bleeding.[12] Thus, knowledge of NF becomes important in orthopedic surgical procedures & medico legal cases. In free vascular bone grafting, Nutrient Artery is important for osteoblast and osteocyte cell survival & facilitating graft healing in recipient.[11] Preoperative angiography excludes any possible vascular anomalies in both recipient & donor bones for microvascular bone transfers.[5] The bone defect which is left behind after traumatic injuries, tumors resection procedures & pseudoarthrosis can all be reconstructed by bone grafting procedures & preferred method is free vascularized bone graft.[13] Detailed data on blood supply to long bones & association with areas of bone supplied has been a major factor in the development of new transplantation & resection techniques in orthopedics.

Aims & Objectives

Keeping in mind the clinical importance of Nutrient Foramen (NF) in tibia, the present study was conducted for determination of: -

1. Number of NF
2. Position of NF relative to surface of tibia
3. Location of NF determined by calculating Foramina Index (FI)

$$FI = \frac{DNF}{TL} * 100$$

DNF= Distance of diaphyseal NF from proximal end of bone.
TL= Total bone length

1. Size of NF, whether dominant or secondary
2. Direction of NF

Materials & Methods

The study was conducted in Department of Anatomy, T. S. Misra Medical College & Hospital, Lucknow. A total of 50 adult human cleaned and dried tibia were examined irrespective of side & sex. Materials used in present study were-

1. Magnifying lens
2. Bone osteometer
3. Metallic measuring scale
4. Guide wire
5. 24 hypodermic needle (0.56mm. in diameter)
6. Digital camera for illustration
7. Digital caliper [(measurement to nearest 0.1 mm) Kizilkanat et al., 2007]

With the help of above mentioned instruments, our observation was done as follows:

1. NUMBER OF NF

NF were observed with the help of hand lens. They were identified by their elevated margins and distinct groove proximal to them. NF on diaphysis only were accepted & foramina at the ends of tibia were ignored.

2. POSITION OF NF

It was determined in respect to different surfaces of tibia by direct inspection.

3. SIZE OF NF

NF $\geq$ 24 hypodermic needle, were taken as Dominant. (DF) (Kizilkanat et al; 2007)

NF $\leq$ 24 hypodermic needle, it was considered as secondary foramen (SF).

4. LOCATION OF NF

Location of dominant NF only was considered. The location was calculated as FI using the formula-

$$FI = \frac{DNF}{TL} * 100$$ (Hughes, 1952; Shulman, 1959)

FI= FORAMINAL INDEX
DNF= DISTANCE OF diaphyseal NF from proximal end of bone

TL= TOTAL BONE LENGTH (Total length of tibia was taken as distance between proximal margin of medial condyle and tip of medial malleolus.)

The location of NF was divided into 3 types according to FI as follows-

Type 1- FI < 33.33%, NF was in proximal 1/3rd of tibia.
Type 2- FI 33.33% -66.66%, NF was in middle 1/3rd of tibia.
Type 3 - FI > 66.66%, NF was in distal 1/3rd of tibia.

1. DIRECTION OF NF

A fine stiff wire was used for this purpose.

2. STATISTICAL ANALYSIS

The results were analyzed and tabulated using Epi-Info 7.The range, mean & SD of FI were determined.

Results: All the foramens were in posterior surface and direction was distal. In present study we observed that the Foramen index was ranging from 29.3 – 41.8. The observations of our present study is tabulated in Table 1.

Table .1

No. of Foramen Present in Tibia				Size of the NF		Location of Foramen		Foramen Index		
One	Two	Three	Four	Primary (Dominant)	Secondary	Middle 1/3	Upper 1/3	Range	Mean	SD
42	4	3	1	50	7	25	25	29.3-41.8	33.3	2.64

Discussion: In the present study, we observed that most of the tibia had a single primary diaphyseal nutrient foramen. This was in accordance to the previous study done by Murlimanju et al..[14] In the present study, no absence of foramina was observed. Patel et al. reported that almost all the tibia had a single primary nutrient foramen.[15] A previous study revealed that 96% of tibia had a single nutrient foramen on its posterior surface.[16] In present study, we observed that the mean foramina index was 33.32 in tibia. This observation was almost close to the previous study done by Murlimanju et al.[14] In present study, we observed that majority of the foramina were on the posterior surface of tibia. This observation was in accordance to the previous study done by Murlimanju et al.[14] and Gümüsburun et al.[5] in their studies. Pereira et al. reported that most of the nutrient foramina in their study were located on the posterior aspect in the lower limb bones.[17]

Conclusion: Majority of the primary diaphyseal nutrient foramina of tibia are located on the posterior surface. In the tibia majority of the foramina are in the upper third on the posterior surface. Preservation of the nutrient foramina and the nutrient artery of the recipient as well as donor is essential for successful bone grafting.[18] The surgeon must preserve the nutrient artery of the bone during fracture fixation for successful healing of the fracture site.[19] Further studies are required to illustrate the size, location, position and direction of NF of Tibia.

References:

1. Gotzen, N., Cross, A., Ifju, P., Rapoff, A. Understanding stress concentration about a nutrient foramen. J. Biomech.36:15:11-21
2. Lewis, O.J. The blood supply of developing long bones with special reference to the metaphysis. J. Bone Jt. Surg, 1956; 38: 928 – 33
3. Brookes, M. Blood supply of long bones. Br. Med. J., 1963;2:1064- 5.
4. Sendemir, E., Cimen, A. Nutrient foramina in the shafts of lower limb long bones: situation and number. Surg. Radiol. Anat, 1991; 13: 105 – 8
5. Gumusburun, E., Adiguzel, E., Erdil, H., Ozkan, Y., Gulec, E. A study of the nutrient foramina in the shaft of the fibula. Okajimas Folia Anat. Jpn1996; 73 (2-3): 125 – 8.
6. Kizilkanat Emine Dondu, Boyan Neslihan, et al. Morphometry of hypoglossal canal, occipital condyle and foramen magnum: abstract, Neurosurgery quarterly 2006; 16(3): 121- 25
7. Trueta, J. Blood supply and the rate of healing of tibial fractures. Clin. Orthop. Rel. Res, 1974;105: 11-26.
8. Mysorekar, V.R. Diaphysial nutrient foramina in human long bones. J Anat, 1967;101: 813 – 22
9. Bokariya, P. Gudadhe, Kothari, Murke, MR Shende, Comparison of Humerus and Femur with Respect to Location and Number of Nutrient Foramina Indian Journal of Forensic Medicine and Pathology.2012;2:79-81.
10. Al-Motabagoni. The arterial architecture of the human femoral diaphysis. J. Anat. Soc. India, 2002. 51(1): 27 – 31.
11. Craig, J.G., Widman, D., van Holsbeeck, M. Longitudinal stress fracture: Patterns of edema and the importance of the nutrient foramen. Skeletal Radiol, 2003; 32: 22-27
12. Collipal, E., Vargas, R. Parra, X., Sliva, H., Sol, M. Diaphyseal nutrient foramen in the femur, tibia and fibula bones. Int. J. Morphol., 2007; 25 (2): 305 – 8.
13. Pho RWH. Microsurgical technique in orthopaedics. 1st ed. Scotland: Butterworth, 1988.
14. Murlimanju BV, Prashanth KU, Prabhu LV, Kumar CG, Pai MM, Dhananjaya KVN. Morphological and topographical anatomy of nutrient foramina in the lower limb long bones and its clinical importance. AMJ. 2011; 4: 530-37
15. Patel S, Vora R, Jotania B. A Study of Diaphyseal Nutrient Foramina in Human Lower Limb Long Bones, Natl J Integr Res Med, 2015, 6(3): 14-8.
16. Sharma M, Prashar R, Sharma T, Wadhwa A, Kaur J. Morphological variations of nutrient foramina in lower limb long bones, Int J Med and Dent Sci, 2015, 4(2):802-8.
17. 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.
18. Wavreille G, Dos Remédios C, Chantelot C, Limousin M, Fontaine C. Anatomic bases of vascularized elbow joint harvesting to achieve vascularized allograft, Surg Radiol Anat, 2006, 28: 498–510
19. Longia GS, Ajmani ML, Saxena SK, Thomas RJ. Study of diaphyseal nutrient foramina in human long bones, Acta Anat, 1980, 107: 399–406.