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Study of nutrient foramina of human tibia of Saurashtra region

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Abstract
Introduction: On the shaft of tibia surface openings for entry of blood vasculature is known as nutrient foramen which leads to nutrient canal to provide a pathway for blood vessels to reach medullary cavity. Topographical information about nutrient foramen is very crucial during various orthopedic surgical procedures.
Objective: Present study is conducted to find out the number of nutrient foramina, its location and direction in relation to growing end of bone and to calculate foraminal index of human tibia.
Material and Methods: In present study 61(30 right and 31 left sided) tibia bone were studied. Age and sex of the bone were unknown. Only fully intact bone without any disease were included. Surface location and direction of nutrient foramina were recorded. Total length of tibia was measured with osteomatric board. Distance of nutrient foramen from proximal end was measured with digital vernier caliper. And foraminal index was calculated. All data was tabulated and analysed statisticaly.
Result: Out of total 61 tibia 95.08% of tibia had one nutrient foramen, 3.28% tibia had two foramen and 1.64% were devoid of nutrient foramen. Almost all (98.33%) of the nutrient foramina were detected on the posterior surface, only 1.67% were on lateral surface. Zone I contained 48.33% and Zone II contained 51.67% of foramina. Not a single bone had foramen in Zone III. Direction of all foramina were towards lower end of tibia except one bone.
Conclusion: Thorough knowledge of morphology of nutrient foramina is necessary for preserving the nutrient arterial blood supply. Because it is very crucial in bone grafting, fracture healing, joint replacement therapy and vascularised bone micro surgeries.

Keywords: Tibia, Foraminal index, Nutrient foramen, Fracture, Morphometry.

Introduction

Long bones are usually supplied by one or two arteries known as nutrient arteries which enters through nutrient foramina and travel through nutrient canal to provide blood supply to inner cortex and medullary cavity of long bone. Nutrient canal opens externally at certain location on the bone surface, called nutrient foramina.[1] Nutrient canal is positioned obliquely in shaft of long bone, so nutrient foramen is also placed obliquely on bone surface so that it is directed toward one of the ends of long bone. The direction of the nutrient foramina is away from the growing end of the bone, but it is not always true in case of mammals.[2,3] Preserving the nutrient arterial blood supply is vital in Bone grafting, fracture healing, joint replacement therapy and vascularised bone micro surgeries.[3,4] In tibia nutrient artery is usually single in number and located on the posterior surface and nutrient foramen usually lies near the soleal line.[5] Direction of foramen is generally towars lower end. Studies on the vascularization of long bones of various populations were conducted analyzing the nutrient foramina morphometry and the vascular anatomy in reconstructive surgeries.[6-9]

Present study was aimed to observe and measure the nutrient foramina of tibia of saurashtra region and to find out that observation coincides or differs from other studies.

Material and Methods

In this study 61 human tibia (30 right and 31 left sided) from Department of Anatomy P. D. U. Medical College, Rajkot were included. Age and Sex of bones were unknown. Damaged bones were excluded from study. In each bone all surfaces of shaft were observed with hand lens to find out nutrient foramina. Criteria for identification of foramen were a bony groove in front of foramen and diameter of foramen were measured by inserting needles of various gauge. Foramina allowing insertion of 24 gauge or thicker needle were noted and studies. With osteometric board total length of bone was measured. (Fig. 3). With digital vernier caliper distance of proximal end of tibia from nutrient foramen was measured. (Fig. 2). It was measured from highest point of intercondyler eminence to margin of nutrient foramen. Then Foraminal index was calculated using formula FI= (DNF/TL) ×100 by Hughes 1952[10] and Shulman 1959[11] where FI is Foraminal Index, TL is total length of tibia and DNF is distance of proximal end of tibia from nutrient foramen. Location of nutrient foramen on shaft was classified in three Zones by value of foraminal index. Zone-I: FI less than 33.33, foramen in upper 1/3rd of shaft, Zone-II: FI between 33.33 and 66.66, foramen in middle 1/3rd of shaft, Zone-III : FI more than 66.66 foramen in lower 1/3rd of shaft. All the data was tabulated and analysed stastically.

Results

Data of number of nutrient foramen in tibia is tabulated in Table-1.In this study we observed that 95.08% of all tibia had only one nutrient foramen. In 3.28% cases tibia had dual nutrient foramen (Fig. 1). In 1.64% tibia nutrient foramen was absent at all.

Table 1: Number of nutrient foramina of tibia

No of nutrient foramen	Right		Left		Total	
	No. of Tibia	%	No. of Tibia	%	No. of Tibia	%
0	01	3.33	00	00	01	1.64
1	28	93.34	30	96.77	58	95.08
2	01	3.33	01	3.23	02	3.28
Total	30	100	31	100	61	100

In all the tibia of both side Nutrient foramen was present on its posterior surface. In a tibia having double nutrient foramen larger foramen was present on lateral surface and smaller foramen was present on posterior surface. In another tibia having double foramen both were present on posterior surface. Table-2 shows that 48.33% of tibia have foramen in upper 1/3rd of shaft (Zone-1), 51.67% of tibia have foramen in middle 1/3rd of shaft (Zone- II). Observation shows that lower 1/3rd of shaft (Zone- III) of tibia is devoid of nutrient foramen.

Table 2: Showing distribution of nutrient foramen in respect to zone of tibia

Zone	Right (29)		Left (31)		Total (60)	
	Number	%	Number	%	Number	%
Zone I	15	51.72	14	45.16	29	48.33
Zone II	14	48.28	17	54.84	31	51.67
zone III	00	00	00	00	00	00
	29	100	31	100	60	100

Nutrient foramina were directed towards the lower end of tibia (Fig. 1) except one bone having foramina directed towards upper end.

Table 3 shows the mean value and standard deviation (SD) and range of values of TL, DNF and foraminal index of tibia. Total length of tibia have mean±SD of 36.45±2.39 cm; DNF have mean±SD of 12.39±1.92 cm and foraminal index have mean±SD of 34±4.65 %.

Table 3: Mean values, SD and range of statistical measurements of nutrient foramina of tibia

Parametre	Right 29	Left 31	Total 60
Mean±SD of TL	36.49±2.46 cm	36.41±2.33 cm	36.45±2.39 cm
Range of TL	31-41.5 cm	31.8-42.2 cm	31-42.2 cm
Mean±SD of DNF	12.53±2.49 cm	12.27±1.13 cm	12.39±1.92 cm
Range of DNF	9.95-23.89 cm	9.36-14.45 cm	9.36-23.89
Mean±SD of FI	34.35±6.31%	33.68±2.12%	34±4.65 %
Range of FI	26.04-63.87%	28.64-37.34%	26.04-63.87%

TL= total length, DNF=Distance from proximal end to NF, FI= Foraminal Index

Fig. 1: Nutrient foramen in tibia

Fig. 2: Measuring DNF

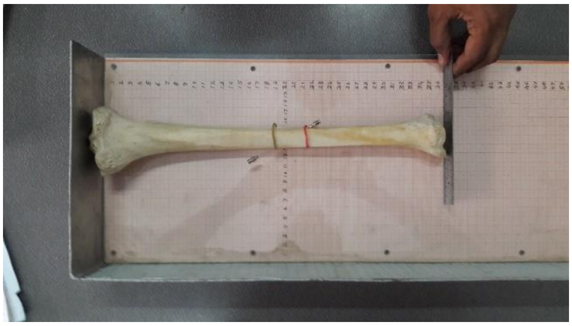

Fig. 3: Measuring total length of tibia

Discussion

Number of nutrient foramina

Majority of tibia had one nutrient foramen(95.08%) in comparision to that of double (3.28%), and no nutrient foramen (1.64%). Which correspond with other studies on tibia like Mysorekar VR,[12] Forriol Campos F et al[13] and Sendemir E et al.[14]

Direction of nutrient foramen

Almost all nutrient foramina were directed towards lower end of tibia except one bone which correlates with other studies.

Position of nutrient foramina

Majority of foramina were lying near junction of upper 1/3rd and middle 1/3rd of shaft of tibia. These results are confirmatory with the other studies like Mysorekar VR,[12] Forriol Campos F et al[13] and Sendemir E et al.[14]

Clinical relevance

Position and number of the nutrient foramina in long bones is very important in orthopedic surgical procedures like joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery.[15] Nutrient arteries get commonly injured during fracture, disclocation and during treatment of the same. The levels of osseous section are selected according to the localization of the diaphyseal nutrient foramina in order to preserve diaphyseal vascularization of the recipient to support the consolidation with the osseous graft.[16]

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