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Original Research Article

VARIATION IN THE NUMBER AND POSITION OF NUTRIENT FORAMINA OF LONG BONES OF LOWER LIMB IN NORTH INDIANS

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ABSTRACT

Aims and Objectives: The major blood supply of the long bones is through the nutrient arterywhich enter through the nutrient foramina leadinginto an oblique nutrient canal. The presence, number, position and distances from the various prominent landmarks on the bone have medical as well as surgical significance. The present study was done on the long bones of North Indians to know the mean values of the number, position of nutrient foramina and distance from various landmarks on the bones and ultimately to compare with other populations.

Materials and Methods: The present study consists of 180 long bones of lower limb (60 femora, 60 tibiae, 60 fibulae) which were taken from Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah (Amritsar), India and studied carefully for the number, position and distance of nutrient foramina in relation to length and from the proximal epiphysis of the long bones. Also the anteroposterior and lateromedial diameter of the bone at the level of nutrient foramen were studied**.**

Main outcome measure: Variations in number, position and distance in relation to length and from proximal epiphysis of long bones was seen.

Results: The nutrient foramen of femur was located on the linea aspera in 76.50% of cases(39% in interstice 9.5% on the lateral lip and 28.00% on the medial lip of the linea aspera), 18.50 %on the medial surface and 5%.on the lateral surface. Nutrient foramen of tibia was located in 95.50% of cases under the soleal line at the average distance of 119.8 mm from intercondylar eminence to the nutrient foramen, on the soleal line in 4%and on the lateral border in 0.50% of cases. Nutrient foramen of fibula was found on the posterior surface in 65 % of cases, in 15% on the medial surface, on the interosseous border in 10% ,on the lateral surface in 7% and on the posterior border in 3% of cases.

Conclusion: This study will provide the ethnic data for comparison among various populations. It is also helpful in various surgical procedures and in interpretation of radiological images.

KEY WORDS: Femur, Fibula, Linea aspera, Nutrient, Tibia.

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INTRODUCTION

The nutrient foramina are the foramina which lead into canals carrying nutrient vessels and usually directed away from the growing end [1]. The nutrient foramina are important not only morphologically but also from the clinical aspect. Nutrient foramina reflect not only bone vascularization but also pathological bone conditions like fracture healing, developmental abnormalities or acute haematological osteomyelitis [2]. The major blood supply for the long bones is derived from nutrient artery [3].

Sometimes it is absent then the vascularization occurs through the periosteal vessels [4]. The blood supply is essential in various procedures like bone grafts, tumor resections, traumas, transplant tprocedures in orthopaedics [5,6]. The nutrient artery should be preserved in the bone grafting to promote fracture healing [7]. The bone transplant procedures require a statistical data on position of nutrient foramen specific to that population which can help the surgeons to select the osseous section levels of the receptor in order to preserve the nutrient artery [8].

The number and position of the nutrient foramen are also important in success of fracture treatment. Both periosteal and medullary blood supply explain the success of nailing of long bone fracture in case of femur and tibia and also the use of vascularized fibular grafts in bony defects [9]. The nutrient foramen of the tibia on the posterior surface of the shaft below the soleal line or at the vertical line below the soleal line and for the fibula is usually situated on the medial crest approximately at the midpoint of diaphysis[3]. Vascularized bone grafts can be used in various condition such as stabilization of lateral mandible, spine and even tibia [10].

A number of complications occur during fibular graft harvesting like neurovascular injuries, compartment syndrome and ankle instability. Thus statistical data regarding the position of nutrient foramen in different populations can improve the results and minimize the complications [11,12]. The aim of the study is to record the location and number of the nutrient foramina in lower limb long bones in North Indians and compare the data with other populations.

MATERIALS AND METHODS

180 dry adult long bones of lower limb (60 femora, 60 tibiae, 60 fibulae) of unknown sex were taken from Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, Punjab, India. Each bone was carefully studied for the presence, number and position of nutrient foramen taken into account the laterality of bone. The right and left side bones were identified. Foramina smaller than a size 24 hypodermic needle were considered the secondary foramina [13.14]. These were not analysed and not included in the present study. The dominant foramen was considered as the nutrient foramen. Location of the nutrient foramen was determined by calculating the foraminal index (FI) according to Hughes[15] using the formula FI=DNF/TLX100 where DNF=Distance from the proximal end of the bone to the nutrient foramen and TL=Total bone length. Determination of the total length of bone was determined according to Campos et al[16]. All measurements were taken with osteometric board and digital calipers.

RESULTS

Most of the nutrient foramina in the long bones of lower limb are located on the posterior surface of the boneie 93.3% in femur,95% in Tibia and 98.3 % in fibula(Table1).

The average length of the right femur was 430.6mm (386-520mm).Average length of the left femur was 432.8 mm(391-523mm) .Nutrient foramen was located on the linea aspera in 76.50 % of cases(39.00% in interstices,9.50% on the lateral lip and 28% on the medial lip).

The average length of right tibia was 351.6mm (317-431mm) and average length of left tibia was 349(307-442mm).Nutrient foramen of tibia was located in 95.50% of cases under the soleal line at the average distance of 119.8mm from inter condylar eminence to the nutrient foramen, on the soleal line in 4% and on the lateral border in 0.50% of cases. Average length of right fibula was 347 mm (312-421mm)and average length of left fibula was 343.6mm(294-378mm). The nutrient foramen was present on the posterior surface in 65%, on the medial surface in 15%, on the medial border in 10%, on the lateral surface in 7% and on the posterior border in 3%

of cases. The various measurements taken were shown in Table1 and 2. Comparison in the parameters in different population was shown in Table 3.

Table 1: Showing the number of foramina in long bones of lower limb in North Indians.

Bone	Side	Bone showing single foramen		Bone showing two foramina		Bone showing three foramina	
		Number	Percentage	Number	Percentage	Number	Percentage
Femur	Right(35)	16	45.71	18	51.43	1	3.3
	Left(25)	13	52	11	44	1	3.3
Tibia	Right(30)	28	93.34	2	6.6	-	-
	Left(30)	29	96.67	1	3.3	-	-
Fibula	Right(30)	24	80	6	20	-	-
	Left(30)	26	86.4	4	13.3	-	-

Table 2: Showing the mean and standard deviations of the measurements taken for the long bones of lower limb in North Indians.

Bone	Measurements	Right		Left	
		Mean	SD	Mean	SD
Femur	Length	430.6	25.6	431.8	26.1
	Distance between the NF and superior border of greater trochanter	196.2	47.9	198.5	48.2
	Anteroposterior diameter at the level of nutrient foramen	26.7	3.4	27.8	2.1
	Lateromedial diameter at the level of nutrient foramen	26.6	2.2	26.2	4.6
Tibia	Length	351.6	26.5	349	27.1
	Distance between the nutrient foramen and apex of intercondylar eminence	122.2	17.5	116.5	12.2
	Anteroposterior diameter at the level of nutrient foramen	33.6	3.2	34.2	2.7
	Lateromedial diameter at the level of nutrient foramen	25.1	2.8	23.9	1.6
Fibula	Length	347	23.6	343.6	27.2
	Distance between the nutrient foramen and apex of the head	169.3	33	170.1	31.2
	Anteroposterior diameter at the level of nutrient foramen	14.6	2	14.1	1.6
	Lateromedial diameter at the level of nutrient foramen	13.4	2.2	13.1	2.8

Table 3: Showing the comparison of the observations of the nutrient foramina of femur by different authors.

Sr No	Author	Year	Various numbers of Nutrient foramina in femur			
			One	Two	Three	Absent
1	Kirschner et al	1998	35	57	8	----
2	Pereira et al	2011	97.4	40	1.28	---
4	Prashanth et al	2011	47.7	44.2	3.5	4.6
5	Present study	2015	48.85	47.71	3.3	----

DISCUSSION

Femur: The present study showed single nutrient foramen in femur in 48.85% of cases(Table1) as shown by Mysorekar[17](50%), Sendemir and Cimen[18] (46%),Prashanth et al [19](47.7%) and Collipal et al[20] (44%)but Pereira et al[21] showed as high as 97.4% of cases. The double nutrient foramina were found in 47.71% of cases (Table1) as shown by Pereira et al[21]. Mysorekar[17]; Sendemir and

Cimen[18]; Gumusburun et al[5] but it was less than noted by Campos et al [16](75%), Kizikanat et al[22](60%). 3.3% of the bones showed three nutrient foramina(Table1) but Campos et al [16] and Gumusburun et al[5] showed incidence as high as10%. No case of absent nutrient foramen was found. It was in agreement with Sendemir and Cimen[18]but Gumusburun et al [5] reported it as 1.9%. Most common position of nutrient foramen (76.5%) in femur was middle one third of the shaft of femur on the linea aspera as also given by Sendemir and Cimen [18]. Mysorekar[17]. Next most common position of the nutrient foramen was on the medial (18.50) and lateral surface(5%) as given by Collipal et al[20]. No case was found with the nutrient foramen present on the anterior surface as shown by Sendemir and Cimen [18].

Tibia: Single nutrient foramen in tibia was found in 95.05% of cases also shown by Guo[23], Campos et al[16], Gumusburun et al[5], Lee et al, Kizikanat et a[22]. Two foramina were found in 4.95% of cases. No tibia with absent nutrient foramen was found but contrary to that Gumusburun et al [5] showed 3.3% and Kizikanat et al[22] showed 1.3%. None of the bone showed three foramina but Gumusburunet al[5] showed 2.8% of cases. Nutrient foramen of tibia was located in 95.50% of cases under the soleal line at the average distance of 119.8mm from inter condylar eminence to the nutrient foramen, on the soleal line in 4% and on the lateral border in 0.50% of cases. Single nutrient foramen of fibula was found in 89.5 % of cases and double in 10.5% of cases as shown by Mysorekar [17](92.85%), Longia et al[7] (85.19%), Sendemir and Cimen[18](73.9%), Forriol et al [24](100%). No tibia showed three nutrient foramina as shown by Gumusburun et al[5] (2.8%). None of the fibula showed absent nutrient foramen in the present study.

Fibula: The predominant nutrient foramen was found more commonly in the middle one third on the posterior surface of the fibula as shown by McKee et al[25], Gumusburun et al[5], Lee et al[14], Kizikanat et al[22] but Pereira et al[21] found it more commonly on the lateral surface and mainly on the upper one third of the shaft by Guo[23] . This is the segment with the nutrient foramen that must be used for transplant that include the endosteal and peripheral vascularisation. Adequate dissection around the position and location of nutrient foramen will minimize the length of the incision given for taking fibular vasularized grafts. This will minimize the complication of procedures such as compartment syndrome[26].

CONCLUSION

The present study provides the information regarding the position and number of nutrient foramina in long bones of lower limb in North Indians and results are consistent with the previous studies.The distribution of the nutrient foramina in the lower limb bones is mainly on the posterior aspect and there is predominantly single foramen in most of the cases. The areas of nutrient foramen distribution must be avoided during surgery as in most of the cases it can be a single source of blood supply. The study will provide the ethnic data related to the North Indian population for comparison as well as in various surgical procedures and in interpretation of radiological images,

Conflicts of Interests: None

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