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Morphological Study of Nutrient Foramen in Femur, Tibia and Fibula

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Abstract

Introduction: During corrective surgeries of the bone the position of the nutrient foramen and their variations is a must know to preserve the nutrient artery as it is the chief blood supply to the inner two thirds of the cortex of long bones. This will guide the surgeons into successful outcomes.

Materials and methods: The study was done on 120 long bones of lower limb obtained from the Department of Anatomy of Government Thoothukudi Medical College, Tamilnadu, India. The position, number and direction of nutrient foramen were noted and foraminal index was calculated.

Results: 64%, 34% and 2% of the femora respectively had single, double and no nutrient foramina. All the tibiae had single nutrient foramen while 83.3% of fibulae had single foramen and 16.6% had no foramen.

Conclusion: This will add to the database obtained from other studies and help the surgeons.

Keywords: Femur, Fibula, Nutrient foramen, Tibia.

Introduction

The nutrient foramen is a cavity allowing the passage of a nutrient artery and a peripheral nerve into the diaphysis of a long bone[1]. The nutrient artery is the principal source of blood supply to long bones, especially during periods of active bone growth and also in embryonic stages[2].

It has been suggested that the direction of the nutrient foramina is determined by the growing end of the bone, which is supposed to grow at least twice as fast as the non-growing end. As a result, the nutrient vessels move away from the growing end of the bone[3].

This foramen, in the majority of cases is located away from the growing end hence the derivation of the axiom that foramina [4] seek the elbow and flee from the knee[5].

The topographical knowledge of these foramina is useful in certain operative procedures to preserve the circulation[6-8]. Therefore it is important that the arterial supply is preserved in free vascularised bone grafts so that the osteocytes and osteoblasts survive[9].

The nutrient foramen is located in a specific position in each bone. In femur, the nutrient foramen is directed upwards and most commonly located on the Linea Aspera. The main nutrient artery is derived from the 2nd perforating artery. If there are 2 nutrient arteries, they may arise from the 1st and 3rd perforators[10]. In tibia, the nutrient foramen usually lies near the soleal line and is directed downwards. The main nutrient artery is a branch of posterior tibial artery, but sometimes it may also arise at the popliteal bifurcation, or as a branch from anterior tibial artery[10]. In fibula, the nutrient foramen is

located slightly proximal to the midpoint of the posterior surface and is directed downwards. The nutrient artery to fibula is a branch of fibular artery[10]. Knowledge of the anatomy of nutrient foramen of fibula is very important while raising osteofasciocutaneous free flaps of fibula[11]. The vascularized fibular bone grafts are used for stabilization of lost mandible, spine and also tibia. Fibular grafts are also used for reconstructive surgeries after excision of bone tumours and other bony defects[12].

The knowledge of location of nutrient foramen in long bones is of paramount importance to the surgeons as minimal interference with the vascularity of the bone during surgical procedures or during fracture repairs will improve the surgical outcome substantially.

Materials And Methods

The present study was conducted on 120 long bones of lower limb (50- femur, 40- tibia and 30- fibula) of unknown age and sex. The bones were obtained from the Department of Anatomy, Government medical college, Thoothukudi, Tamilnadu. The bones which were complete and fully ossified were included for the study. Incomplete bones and those with pathological changes were not included in the study. Only the diaphyseal nutrient foramen was observed for the study. The number of nutrient foramina in each bone was noted. The size of the nutrient foramen was measured using a hypodermic needle. Nutrient foramina which did not allow the passage of a size 24 gauge needle were considered as secondary nutrient foramina. Nutrient foramina which allowed the passage of size 24 gauge needle were considered as dominant nutrient foramina[10]. The direction of the nutrient foramen was assessed by passing a hypodermic needle into the nutrient foramen. The location of the nutrient foramen in each long bone was noted in relation to the nearby anatomical structures. The distance of the dominant nutrient foramen (DNF) from the highest point of the proximal part of the long bones was measured with a vernier calipers. The total length (TL) of the bone was measured using an osteometric board. The location of the nutrient foramen in the upper, middle or lower third of the bone was determined using Hughes formula for foraminal index (FI). FI= DNF / TL X 100. The nutrient foramen was localised to the proximal, middle and distal third of the shaft of the bone based on the foraminal index as follows: FI less than 33.33 – the nutrient foramen was in the proximal third of the bone FI from 33.33 to 66.66 – the nutrient foramen was in the middle third of the bone FI greater than 66.66 – the nutrient foramen was in the distal third of the bone. All the observations were carefully tabulated and statistically analysed using Microsoft excel worksheet.

Results

The following are the results for Femur

Out of the 50 femur which was used for the study 32 femora (64%) had single nutrient foramen *(Fig 1)*. 17 femora (34%) had two nutrient foramen *(Fig 2)* and one femur (2%) had no nutrient foramen. 74.4% of the nutrient foramen are dominant as they allowed the passage of 24 gauge needle and 25.75% of them were considered to be secondary as they did not allow the passage of the needle. All the foramen were directed upwards.

The total length of the femur was found to be between 37.2cm to 49.4cm, the average being 42.28cm. The distance of the dominant nutrient foramen from the proximal end ranged between 12.2cm to 29.3cm. The average was 18.62cm.

The foraminal index was between 31.12 and 61.75. The average was 43.93. 4 femur had FI less than 33.33, rest of the 45 femora had FI between 33.33 and 66.66. The positions of the nutrient foramen were as follows

On linea aspera -18

Medial lip of linea aspera – 14

Lateral lip of linea aspera – 8

Medial to linea aspera – 11

Between spiral line and gluteal tuberosity – 9

Spiral line – 2

Gluteal tuberosity – 1

Medial to gluteal tuberosity - 3

Results For Tibia Are

Among the 40 tibiae that were examined, all the tibiae had nutrient foramen *(Fig 1)*. All the foramen were directed downwards. All the foramen were

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found to be dominant as they allowed the passage of the 24gauge needle. The distance of the foramen from the proximal end of the bone spanned from 9.4cm to 13.4cm, the average being 11.74cm

The average length of tibia was 35.96cm the smallest tibia was 31.1cm and the longest was 40.4cm. The foraminal index ranged 26.09 to 37.46. The average was 33.49. Of the 40 tibiae, 18 of them had FI between 33.33 and 66.66. The rest 22 had FI less than 33.33.

The positions of the nutrient foramen are

Below soleal line & medial to vertical line – 6

Below soleal line & lateral to vertical line – 32

Above soleal line – 1

Interosseous border – 1

Results For Fibula Are

30 fibulae were examined. 25 fibulae among them had single nutrient foramen *(Fig 1)* and 5 of the fibulae did not have any nutrient foramen. The foramen were about 11.2cm to 20.8cm from the proximal end of the bone, the average was 14.97cm. The length of the fibulae were between 29.9cm and 40.4cm. The average was 34.91cm. The foraminal index whose average was 41.64 ranged between 34.56 and 57.77.

The positions of the nutrient foramen as follows

On the medial crest – 14

Lateral to medial crest – 6

Medial to medial crest – 5

Table 1: Comparing the observations of nutrient foramen of Femur with other studies

Femur	Present study (%)	Kalyasundaram mohan et al [13] (%)	Prashanth et al [14] (%)	Patel S et al [15] (%)
Single foramen	64	64	47.7	60
Double foramen	34	30	44.2	40
Triple foramen	-	6	3.5	-
Absent foramen	2	-	4.6	-

Table 2: Comparing the observations of nutrient foramen of Tibia with other studies

Tibia	Present study (%)	Kalyasundaram mohan et al [13] (%)	Prashanth et al [14] (%)	Patel S et al [15] (%)
Single foramen	100	98	98.6	100
Double foramen	-	2	-	-
Absent foramen	-	-	1.4	-

Table 3: Comparing the observations of nutrient foramen of Fibula with other studies

Fibula	Present study (%)	Kalyasundaram mohan et al [13] (%)	Prashanth et al [14] (%)	Patel S et al [15] (%)
Single foramen	83.3	98.6	90.2	80
Double foramen	-	1.33	-	20

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Absent foramen	16.6	-	9.8	-

Figure 1: Pink head pins shows the position and direction of single nutrient foramen noted in femur, fibula and tibia respectively from left to right.

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Figure 2: Pink head pins shows the position of double nutrient foramen noted in femur.

Discussion

The number of nutrient foramen observed in Femur, Tibia and Fibula were compared with similar studies done by Kalyasundaram mohan et al[13], Prashanth et al[14] and Patel S et al[15].

For femur the present study was coinciding with that of Kalyasundaram mohan et al[13] (*Table 1*), the

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observations of Tibia were similar to the study done by Patel S et al[15] (*Table 2*), while the results of Fibula were not totally falling in line but was close to that of Patel S et al[15] (*Table 3*).

Similarly, for each bone it's average length, distance of dominant foramen from proximal end and foraminal index were compared with Kalyasundaram mohan et al[13] .

The corresponding values for femur from present study were 42.28cm, 18.62cm and 43.93 as opposed to 42.29cm, 17.11±5.42cm and 40.55±8.32 from Kalyasundaram mohan et al[13]. So the results were found to be similar.

The corresponding values for tibia from present study were 35.96cm, 11.74cm and 33.49 and that from Kalyasundaram mohan et al[13] were 36.58±2.38cm, 12.70±3.64cm and 34.74±4.08. The values of present study were almost close to that of Kalyasundaram mohan et al[13].

The corresponding values for fibula from present study were 34.91cm, 14.97cm and 41.64. The observations from Kalyasundaram mohan et al[13] were 35.36±3.26cm, 14.12±3.75cm and 39.93±7.32. The present study were well within the range of Kalyasundaram mohan et al[13].

Conclusion

The foramen may be a potential area of weakness in some patients and, when under stress because of increased physical activity or decreased quality of the bone, the foramen may allow development of a fracture. Position of the fracture relative to the nutrient foramen of the long bone and the patterns of edema are the secondary signs in the key of the diagnosis of this type of fracture[16].

The precise knowledge of the location, direction, number and size of the nutrient foramina of long bones of lower limb will help the orthopaedicians during fracture repair surgeries, tumour resection and also during bone grafting surgeries. The nutrient artery is essential to maintain the growth of osteophytes, hence the nutrient foramina should be preserved during tumour resection surgeries on the bones[13].

References

1. Pereira GM, Lopes PTC, Santos AMPV, Silvera FHS. Nutrient foramen in the upper and lower limb long bones: Morphometric study in bones of southern Brazilian adults. Int J Morphol. 2011;29:514-520.
2. Lewis OJ. The blood supply of developing bones with special reference to the metaphysis. J Bone Joint Surg. 1953;35B(3):462-466.
3. Malukar O, Joshi H. Diaphysial Nutrient Foramina In Long Bones And Miniature Long Bones, NJIRM; 2011, 2 (2): 23-26.
4. Mysorekar VR, Nandedkar AN. Diaphysial nutrient foramina in human phalanges. J Anat 1979; 128:315-322.
5. Patake SM, Mysorekar VR. Diaphysial nutrient foramina in human metacarpals and metatarsals. J Anat 1977; 124:299304.
6. Mysorekar VR. Diaphysial nutrient foramina in human long bones. J Anat 1967; 101:813-822.
7. Taylor GI. Fibular transplantation. In: Sefarin D, Burke HJ, editors. Microsurgical composite tissue transplantation. St. Louis: Mosby, 1979. pp 418-423
8. McKee NH, Haw P, Vettese T. Anatomic study of the nutrient foramen in the shaft of the fibula. Clin Orthop Rel Res 1984; 184:141-144.
9. Green DP. Operative hand surgery. 2nd ed. New York: Churchill Livingstone, 1988. pp 1248
10. 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- 808.
11. Payton CG. The position of the nutrient foramen and direction of the nutrient canal in the long bones of the madder- fed pig. J Anat. 1934;68:500-510.
12. Ebraheim NA, Elgafy H,Xu R. Bone – graft harvesting from iliac and fibular donar sites: Techniques and complications. J Amer Acad Orthop Surg. 2001;9:210218.
13. Kalyanasundaram Mohan, Backiaraj Devaraj, Shalini Ramanathan, Manoranjitham Rethinasamy, Morphometric study of nutrient foramen in the long bones of lower limb. Int J Anat Res 2017;5(2.3):3943-3948. DOI: 10.16965/ijar.2017.225
14. Prashanth KU, Murlimanju BV, Prabhu LV, Kumar CG, Pai MM, Dhananjaya KVN. Morphological and topographical anatomy of nutrient foramina in the lower limb long bones

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and its clinical importance. AMJ 2011, 4, 10, 530-537 http//dx.doi.org/10.4066/AMJ.2011.725

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): 14-18
16. 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.

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