IF : 4.547 | IC Value 80.26 VOLUME-6, ISSUE-7, JULY-2017 • ISSN No 2277 - 8160

Original Research Paper Anatomy

MORPHOMETRIC STUDY OF NUTRIENT FORAMINA IN HUMAN FEMUR BONE

Arvind Deswal M.Sc Demonstrator Deptt. of Anatomy

Dr. SK Srivastava MBBS, MD Ex-Head & Professor Deptt. of Anatomy

Dr. Amit Saxena MBBS, MD Head & Professor Deptt. of Anatomy

Anju Bala M.Sc Demonstrator Deptt. of Anatomy

ABSTRACT

Introduction: Nutrient foramen is a natural opening into the shaft of a bone, allowing for passage of blood vessels into the medullary cavity. The knowledge about the morphology and topography of the nutrient foramen is essential in certain surgical procedures like fracture treatment and microvascular bone grafting. **Aim:** The present study analysed the number, position, location and direction of nutrient foramina in 112 adult dry femur bones. **Methods:** This study conducted on 112 (59 right and 53 left) dry adult fully ossified femur bones. All the important parameters were studied using osteometric board, vernier calipers and other precision measuring instruments. **Results:** Femora had single nutrient foramen in 48.34% of the cases, 22.51% femurs had double nutrient foramen and 3.31% of femurs had triple nutrient foramen. The location of the nutrient foramina is predominant on middle on third of diaphysis (type 2). 55 (35.25%) of femora had nutrient foramina on medial lip of linea aspera, 22.43% on middle area of linea aspera, 34 (21.79%) on upper posterior surface, 13 (8.33%) on medial surface and 5 (3.20%) on lateral surface and 14 (8.97%) on lateral lip of linea aspera. **Conclusion:** The information and details about these foramina is of clinical importance, especially in surgical procedures like bone grafting and microsurgical vascularized bone transplantation. It is also useful in calculating the length of a long bone from a given fragment which is important for medicolegal and anthropological work.

KEYWORDS : Diaphysis, Femur, Linea aspera, Nutrient foramina .

Introduction

The nutrient foramina are cavities that conduct the nutrient arteries and the peripheral nerves on the shaft of long bones. The nutrient artery is the principal source of blood supply to a long bone and is particularly important during its active growth period in the embryo and foetus as well as during the early phase of ossification. (Kumar R et al) During childhood, the nutrient arteries provide 70-80% of the interosseous blood supply to long bones, when this supply is compromised, medullary bone ischemia occurs with less vascularization of the metaphyssis and growth plate. (Kumar R et al, Forriol Campos et al) It has been suggested that the direction of the nutrient foramen 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. As it is popularly stated, they 'seek the elbow and flee from the knee', showing their varying directions in both limbs. (Ukoha, Malukar, Patake SM) The nutrient foramina are important not only morphologically but also from clinical aspect. Nutrient foramina reflect not only bone vascularization but also pathological bone conditions like fracture healing, developmental abnormalities or acute haematological osteomyelitis. (Seema et al)

Materials and methods:

112 dry adult femur bones (59 right and 53 left) of unknown sex were taken from department of Anatomy, SGT medical college, Gurugram, Haryana. Each bone was carefully studied for the presence, number and position of nutrient foramen taken into account the laterality of bone. A magnifying lens was used to observe the foramina. Only diaphysial nutrient foramina were observed in all bones and a 24 gauge needle was passed through each formen to confirm their patency. Foramina smaller than a size 24 hypodermic needle were considered the secondary foramina. The dominant foramen was considered as the nutrient foramen. For those bones which had double nutrient foramina, the large foramen was taken into consideration during the estimation of foraminal index. Location of nutrient foramen was determined by calculating the foraminal index (FI) according to Hughes using the formula

FI= DNF/TL x 100

Where DNF = Distance from proximal end of the bone to the nutrient foramen

TL = Total bone length

Subdivisions of the foraminal position according to foraminal index (FI) can be grouped into three types as follows:

Type 1: FI from 01 up to 33.33 – the foramen is in the proximal third of the bone.

Type 2: FI from 33.34 up to 66.66 – the foramen is in the middle third of the bone.

Type 3: FI above 66.67 – the foramen is in the distal third of the bone.

All the measurements were taken with osteometric board and digital calipers.

The direction of the needle was noted as follow:

(a) If the needle passes upwards, it was noted as upper direction.

(b) If the needle passes downwards, it was noted as lower direction.

(c) If the needle passes horizontally, it was noted as horizontal.

Result:

1. Number of nutrient foramina:

Out of the 112 femur bones, 73 (48.34%) had single nutrient foramina, 34 (22.51%) had double nutrient foramina and 5 (3.31%) of femur bones had triple nutrient foramina. In the right femurs, the present study showed 76.27% of single nutrient foramina. The double foramen was observed in 20.33% of the cases and 3.38% of femora had triple nutrient foramen. In left femurs, the present study showed 28 (52.83%) of single nutrient foramen, 22 (41.50%) of double foramen and 3 (5.66%) of triple nutrient foramen. (Table 1)

Table 1: Showing number of foramina in femur bones.

Side	Single NF n (%)	Double NF n (%)	Triple NF n (%)	Total NF
Right	45 (76.27)	12 (20.33)	2 (3.38)	75

Left	28 (5.83)	22 (41.50)	3 (5.66)	81
Total	73 (48.34)	34 (22.51)	5 (3.31)	156

Location of nutrient foramina:

Out of 112 femora, nutrient foramina in 34 (21.79%) of cases were present on upper posterior surface, 13 (8.33%) on medial surface and 5 (3.20%) on lateral surfaces, 35 (22.43%) on middle area of linea aspera, 55 (35.25%) on medial lip and 14 (8.97%) on lateral lip of linea aspera.

In the present study, in right femur bones, 27 (36.98%) nutrient foramina were on the medial lip of linea aspera, 16 (21.91%) on the upper posterior surface, 11 (15.06%) between the two lips of linea aspera, 9 (12.33%) on lateral lip of linea aspera, 7 (9.58%) on medial surface and 3 (4.11%) on the lateral surface of femora.

In left femurs, the nutrient foramen were present 28 (35.89%) on medial lip of linea aspera, 18 (23.07%) on upper posterior surface, 6 (7.69%) on medial surface, 5 (6.41%) on lateral lip of linea aspera and 2 (2.56%) on lateral surface of femora. (Table 2)

Table 2: Showing location and number of nutrient foramina in femur bones.

Location	Right femora	Left femora	Total
Upper posterior surface	16 (20.51)	18 (23.07)	34 (21.79)
Medial surface	7 (8.97)	6 (7.69)	13 (8.33)
Lateral surface	3 (3.84)	2 (2.56)	5 (3.20)
Middle area of Linea aspera	16 (20.51)	19 (24.35)	35 (22.43)
Medial lip of Linea aspera	27 (34.61)	28 (35.89)	55 (35.25)
Lateral lip of Linea aspera	9 (11.53)	5 (6.41)	14 (8.97)

3. Position of nutrient foramina: Out of the 156 foramina, 118 were located in the middle one third (type I) of the shaft which accounts for 75.64% and rest (24.35%) were in the proximal third (type II). No foramina were located in the lower third of the shaft. (Table 3)

Table: 3 Showing position of nutrient foramina in femur bones.

Topography of foramina	Number of foramina n (%)		Total
	Right	Left	
Proximal third	22	16	38 (24.35)
Middle third	53	65	118 (75.64)
Lower third	0	0	0

4. Direction: Among 112 femora studied, nutrient foramina of all the femora were directed upwards.

5. Size: out of the 156 foramina, 113 (69.64%) were dominant and 43 (30.55%) were secondary foramina. (Table 4)

Table 4: Showing location of dominant (DF) and secondary nutrient foramina (SF) in femur bones.

Location	Number of foramina n (%)		Total n (%)
	DF	SF	
Upper posterior surface	24 (21.23)	10 (23.25)	34 (21.79)
Medial surface	11 (9.73)	2 (4.65)	13 (8.33)
Lateral surface	3 (2.65)	2 (4.65)	5 (3.21)
Middle area of Linea aspera	27 (23.89)	8 (18.60)	35 (22.43)
Medial lip of Linea aspera	38 (33.62)	17 (39.53)	55 (35.25)
Lateral lip of Linea aspera	10 (8.84)	4 (9.30)	14 (8.97)

Discussion:

In the present study, 48.34% of femora had a single nutrient foramen similar to the findings of Seema et al (48.85%), Mysorekar et al (50%), Sendemir and Cimen et al (46%), Prashanth et al (47.7%) and Collipal et al (44%) showed frequency of single nutrient foramen while Pereira et al showed high frequency of single nutrient foramina (97.4%) as compared to present study. 22.5% of femurs had double foramina in the present study which was lesser than the findings of previous authors Seema et al, Pereira et al, Mysorekar et al, Sendemir & Cimen, Campos et al, Kizikanat et al. In the present study, 3.31 % of femora had triple nutrient foramina which were similar to the findings of Seema et al while Gumusburun et al reported 10% incidence of triple nutrient foramina.

In the present study, nutrient foramen of the femur was located in the medial lip of linea aspera in 36.42% cases, in upper posterior surface 22.52%, 19.86% in the middle area of linea aspera, 9.27% in the lateral lip of linea aspera, 8.61% in the medial surface and 3.31% in the lateral surface whereas Collipal et al reported the location of nutrient foramina in the linea aspera in 36.25% cases, 8.75% in the lateral lip and 27.5% in the medial lip of linea aspera, 21.25% in the medial surface and 6.25% in the lateral surface of diaphysis of bone. In the present study, 100% nutrient foramina were directed upwards similar to the findings of Datta M, Bhuvanewasri BJ, Gupta RK et al, Roul B et al whereas differ from the findings of Kumar R in which out of 150 nutrient foramina, 148 were directed proximally and 2 were directed distally. The men value of foraminal index (FI) in the present study was 39.46 close to the findings of Pereira et al (43.7), Forrio Compos et al (38.42) and Gumuburun et al (44.82). in present study, most of the foramina were located in the middle one-third of femora which was in accordance with Forriol Campos et al, Prashanth et al, Kumar R et al, Seshayyan BJ et al.

Conclusion:

The nutrient foramina may be a potential area of weakness of some patients and when under stress because of increased physical activity or decreased quality of 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. Exact location and distribution of the nutrient foramina in the bone diaphysis is important to avoid damage to the nutrient vessels during surgical procedures. As techniques such as microvascular bone transfer are becoming more popular, information relating to the anatomical description of these foramina is vital to preserve the circulation of affected bony structures. The nutrient artery zone of the femur has to be tackled with utmost caution during surgical interventions for subtrochanteric fractures as otherwise it may lead to severe haemorrhage. This study may help orthopaedic surgeons in planning the surgical treatment of fracture of femur with a possible reduction in post-operative complications.

References:

1. Kumar, R., Mandloi, S., Singh, A.K., Kumar, D., Mahato, P. 2013. Analytical and morphometric study of nutrient foramina of femur in Rohilkhand region. IJMHS. 3: 52-54.
2. Forriol, Campos, F., Gomez, L., Gianonatti, M., Fernandez, R. 1987. A study of the nutrient foramina in human long bones. Surg Radiol Anat. 9: 251-55.
3. Ukoha, U.U., Umeasalugo, K.E., Nzeako, H.C., Ezejindu, D.N., Ejimofor, O.C., Obazie, I.F. 2013. A study of nutrient foramina in long bones of Nigerians. National Journal of Medical Research. 3(4): 304-08.
4. Malukar, O., Joshi, H. 2011. Diaphyseal nutrient foramina in long bone and miniature long bones. NJIRM. 2(2):23-26.
5. Seema., Verma, P., Mahajan, A., Gandhi, D. 2015. Variation in the number and position of nutrient foramina of long bones of the lower limb in North Indians. Int J Anat Res. 3(4):1505-09.

6. Patake, S. M., Mysorekar, V.R. 1977. Diaphysial nutrient foramina in human metacarpals and metatarsals. J Anat. 124:299-304.
7. Hughes, H. 1952. The factors determining the directions of the canal for nutrient artery in long bones of mammals and birds. Acta Anat. 15: 261-81.
8. Mysorekar, V.R. 1967. Diaphysial nutrient foramina in human long bones. J Anat.101: 813-22.
9. Sendemir , E., Gimen, A. 1991. Nutrient foramina in the shafts of the lower limb long bone: situation and number. Surg Radiol Anat. 75: 105-8.
10. Prashanth, K.U., Murlimanju, B.V., Prabhu, L.V., Kumar, C.J., Mangala, M.P., Dhananjava, K.Y.N. 2011. Anatomy of nutrient foramina in the lower limb long bones. Australasian Med J. 4 (10): 530-37.
11. Collipol, E., Yargas, R., Parra, X., Silva, H., Mariano, D.S. 2007. Diaphyseal nutrient foramina in the femur, tibia and fibula bone. Int J Morphol. 25(2): 305-08.
12. Pereira, G.A.M., Lopes, P.T.C., Santos, A.M.P.Y., Silveria, F.H.S. 2011. Nutrient foramina in the upper and lower limb bones. Morphometric study in bones of South Brazilian adults. Int J Morpho. 29(2): 514-20.
13. Campos, F.F., Pellico, L.G., Alias, M.G., Valencia, F.R. 1995. A study of nutrient foramina of lower limb bones. Surg Radiol Anat. 16: 409-12.
14. Kizikanat, E., Boyan, N., Ozsahin, E.T., Soamrs, R., Oguz, O. 2007. Location, number and clinical significance of nutrient foramina in human long bones. Ann Anat. 189: 87-95.
15. Gumusburun, E., Yucel, E., Ozkan, Y., Akgun, Z. 1994. A study of the nutrient foramina of the lower limb long bones. Surg Radiol Anat. 16: 409-12.