

A study of nutrient foramina of the dry adult human femur bones**Dr. Poornima B^{*1} and Dr. Angadi A V²**¹Department of Anatomy, Vijayanagar Institute of Medical Sciences, Bellary, Karnataka, India²Department of Anatomy, Shamanur Shivashankarappa Institute of Medical Sciences, Davangere, Karnataka, India***Correspondence Info:**

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E-mail: pnama73@gmail.com**Abstract**

The Femur bone is a highly vascular structure with unique features in its blood supply via numerous foramina located over its different segments, being named as vascular foramina. Among vascular foramina, nutrient foramen is an important one which gives way to the nutrient artery. Knowledge of vascular anatomy is helpful in early identification of vascular interruptions leading to osteonecrosis. The present study was undertaken on 100 dry adult human Femur bones of both sides, irrespective of sex. The bones were obtained from the Department of Anatomy, Shamanur Shivashankarappa Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India. In the present study, among foramina of 100 dry adult human Femora, 62 Femora had single nutrient foramen, 37 had two nutrient foramina and 1 had three nutrient foramina. The medial lip of linea aspera of Femur depicted the presence of nutrient foramina in majority of bones suggesting the entry zone for nourishment of shaft by perforating arteries. Size of nutrient foramina were ranging from size ≥ 0.55 mm to size ≥ 1.27 mm. Direction of nutrient foramina of all the Femora were directed upwards. This study may help orthopaedic surgeons in planning the surgical treatment of fracture of Femur with a possible reduction in post-operative complications. Combined periosteal and medullary blood supply to the bone cortex helps to explain the success of intramedullary reaming of long bone fractures particularly in the weight bearing Femur.

Keywords: Femur, Nutrient foramina, Ischaemic necrosis, Perforating arteries, Nutrient artery.**1. Introduction**

The Femur is the long bone of the thigh. Femur is the bone which is susceptible to the functional hormonal disturbances, aging process and physical traumas which account for its usual fractures and dislocations[1]. The arteries supplying this long bone pervade into it via numerous foramina located over its different segments, being named as vascular foramina. Among these vascular foramina, nutrient foramen is an important one which gives way to the nutrient artery. Knowledge of vascular anatomy is helpful in early identification of vascular interruptions leading to osteonecrosis[2].

2. Materials and Methods

A study of nutrient foramina morphology was conducted on total of 100 dry adult human

Femur bones of either sex from the collection in the Department of Anatomy, Shamanur Shivashankarappa Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India. Deformed, damaged bones, bones with callous formation and unossified bones were excluded from the study.

The materials used to calculate the parameters in this study are as follows:

- 1) Marker pens
- 2) 18, 20, 22, 24 gauge hypodermic needles.

The dry adult human Femur bones were numbered using the marker pen from 1 to 100 numbers in order.

To locate the nutrient foramina, the Femur bone was divided into different segments:

Location (a):

- i) Medial lip of linea aspera
- ii) Lateral lip of linea aspera
- iii) Medial surface
- iv) Upper posterior surface.

Location (b):

- i) At the junction of upper and middle 1/3rd
- ii) At the junction of middle and lower 1/3rd
- iii) At the middle 1/2
- iv) Other locations.

Based on the hypodermic gauge needle number which was admitted by the nutrient foramina, the foramina were categorized into 4 groups.

- a) Large sized nutrient foramina: The foramina which admitted 18 gauge needle were considered to be between 1.27 mm or more [≥ 1.27 mm].
- b) Medium sized nutrient foramina: The foramina which admitted 20 gauge needle were considered to be between 0.90 mm and 1.27 mm [≥ 0.90 mm to < 1.27 mm].
- c) Small sized nutrient foramina: The foramina which admitted 22 gauge needle were considered to be between 0.71 mm and 0.90 mm [≥ 0.71 mm to < 0.90 mm].
- d) Very small sized nutrient foramina: The nutrient foramina which admitted 24 gauge needle were considered to be between 0.55 mm and 0.71mm [≥ 0.55 mm to < 0.71 mm].

The direction of the needle was noted as follows:

- 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.

2.1 Statistical methods

Descriptive statistical methods were employed in the present study.

Figure1: Showing 100 dry adult human Femur bones



Figure 2: Showing hypodermic gauge needle piercing the nutrient foramina of shaft of Femur bone.



Figure 3: Shaft of the Femur bone showing two nutrient foramina.

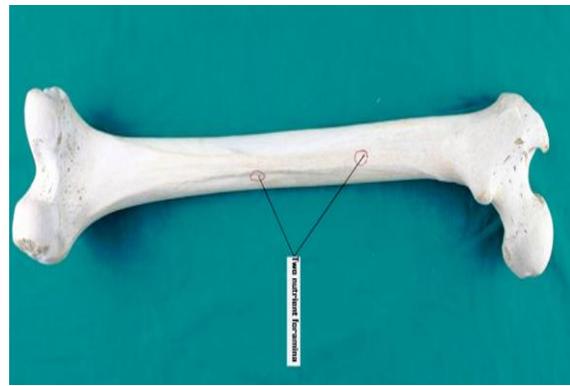
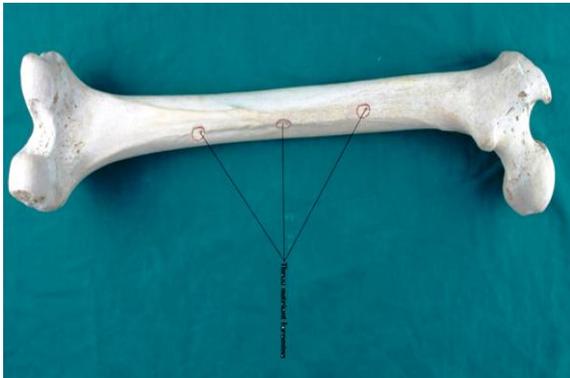


Fig.4: Shaft of the Femur bone showing three nutrient foramina.

**3. Results****3.1 Number/ density of nutrient foramina**

Among 100 Femora studied, 62 Femora had single nutrient foramen, 37 Femora had two nutrient foramina and 1 Femur had three nutrient foramina.

3.2 Location of nutrient foramina

78 nutrient foramina were located at the junction of upper and middle 1/3rd of the Femur i.e., 56.1%.

26 nutrient foramina were located at the junction of middle and lower 1/3rd of the Femur i.e., 18.7%.

32 nutrient foramina were located in middle half of the length of the Femur i.e., 23%.

3 nutrient foramina were located in other locations of the Femur i.e., 2.2%.

3.3 Size of nutrient foramina

7.2 % [i.e., 10] of nutrient foramina were of size ≥ 1.27 mm.

64.7% [i.e., 90] of nutrient foramina were of size ≥ 0.90 mm to < 1.27 mm.

16.5% [i.e., 23] of nutrient foramina were of size ≥ 0.71 mm to < 0.90 mm.

11.5% [i.e., 16] of nutrient foramina were of size ≥ 0.55 mm to < 0.71 mm.

3.1 Direction of nutrient foramina

Among 100 Femora studied, nutrient foramina of all the Femora were directed upwards.

4. Discussion

A typical long bone is fed by four groups of arterial systems, which are - a nutrient artery, epiphyseal, diaphyseal and periosteal arteries[3]. The Femur bone is a highly vascular structure with unique features in its blood supply[1]. The nutrient arteries of the Femur usually arose from the perforating branches of the profunda femori artery, less commonly direct from the profunda femori and rarely from the lower segment of the femoral artery. The course of the nutrient arteries will be constant, the arteries run under the adductor magnus muscle, and through the nutrient foramina which lay on or near the linea aspera of the Femur. The nutrient foramina of the Femur are usually situated on the posterior surface, near the linea aspera of the Femur[3].

Laing PG investigated the details of blood supply of the Femoral shaft in ten adults and seventeen newborn subjects. It was observed that a considerable number of Femora have only one main nutrient vessel supplying the shaft, even including the bones with two such vessels. No major artery entered the lower third of the shaft[5].

Mysorekar VR studied for the number, position, symmetry of the diaphyseal nutrient foramina. His study showed that the arrangement of the diaphyseal nutrient foramina in the long bones of the limbs usually follows a definite pattern. There are often two nutrient foramina in the Femur. In the Femur, the nutrient foramina are restricted to the linea aspera or its immediate neighbourhood in the middle third of the bone[6].

Henderson RG determined the positions of the Femoral and Tibial nutrient foramina by direct measurement in rats of 40, 49 and 59 days of age using a travelling microscope. The Femoral nutrient foramina remained constant in position with increasing age. In case of the Femur, this can be accounted for entirely by differences in growth rates

at the epiphyseal plates of the femur compensating for the disproportion in the distances of the foramen from the two plates[7].

Erika Collipal investigated the 140 dry femora for the location and number of diaphysis foramina. The nutrient foramen of the Femur was located in the linea aspera in the 72.5% and in the 21.25% in the medial surface and in the 6.25% in the lateral surface of the diaphysis of the bone. This data was used as reference for surgical procedures of the lower limb[8].

Pereira GAM studies showed that the location and the number of nutrient foramina in the diaphysis of 885 long bones of the upper and lower limbs of adults. The location of the nutrient foramina is predominant on the posterior aspect of the lower limb long bones. The majority of the bones studied had a single nutrient foramen, which may represent a single source of blood supply. This data was used for comparison and in surgical procedures and in the interpretation of radiological images[9].

In the present study, the nutrient foramina of 100 dry adult human Femora, 62 Femora had single nutrient foramen, 37 had two nutrient foramina and 1 had three nutrient foramina. Location of 78 nutrient foramina were located at the junction of upper and middle $1/3^{\text{rd}}$ of the femur, 26 nutrient foramina were located at the junction of middle and lower $1/3^{\text{rd}}$ of the femur, 32 nutrient foramina were located in middle half of the length of the femur, 3 nutrient foramina were located in other locations of the femur bones. Size of nutrient foramina were ranging from size ≥ 0.55 mm to size ≥ 1.27 mm. Direction of nutrient foramina of all the Femora were directed upwards and density of nutrient foramina was found more close to medial lip of linea aspera and at the junction of upper and middle $1/3^{\text{rd}}$ of the shaft of Femur.

Blood supply to Femur bone is essential during the growing period, during the early phases of ossification, and in surgical procedures such as bone grafts, tumour resections, traumas, congenital pseudoarthrosis, and in transplant techniques in orthopaedics.

4. Conclusion

The nutrient foramen emphasizes the significance of perforating arteries to cater the blood supply to medullary wall and bone marrow. 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. The present study conducted on nutrient foramina of 100 dry adult human Femora arrived at a conclusion that the density of nutrient

foramina was found more close to medial lip of linea aspera and at the junction of upper and middle 1/3rd of the shaft of femur. This location is highlighting, as the nutrient artery may be involved in iatrogenic (or) traumatic injuries. With the results of study of these foramina, it is possible to arrive at surgical implications of the fractures of the Femur like avoiding the entry zones of arteries during plating procedures etc. This study may help orthopaedic surgeons in planning the surgical treatment of fracture of Femur with a possible reduction in post-operative complications. Combined periosteal and medullary blood supply to the bone cortex helps to explain the success of intramedullary reaming of long bone fractures particularly in the weight bearing Femur[2].

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