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RESEARCH ARTICLE
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VARIATION OF POSITIONS OF NUTRIENT FORAMEN IN FEMUR IN BARDHAMAN DISTRICT OF WEST-BENGAL.

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Abstract:
Background: The nutrient foramen is an opening in the bone through which blood vessels and nerves enter the bone. The position of the nutrient foramen in the femur varies between individuals. This study was conducted to determine the variation of positions of nutrient foramen in the femur in Bardhaman District of West Bengal, India.

Objective: Objective was to study the number, position, location, directions, distance of nutrient foramen from the proximal end of femur, tibia and fibula in eastern Indian region.

Results:- Out of 250 femur bone (Right side 156 and left side bone 94) of the nutrient foramina in the long bones of lower limb are located on the posterior surface of the bone 90 % in femur. The average length of the right femur was 40.7 mean value. Average length of the left femur was 41.22 mean value .Nutrient foramen was located on the linea aspera in 77.50 % of cases. These findings are consistent with other studies on the variation of nutrient foramen in the femur. However, the percentage of femurs with the nutrient foramen on the medial surface in the Bardhaman study is higher than what has been reported in other studies.

Conclusion: The knowledge of the variation of positions of nutrient foramen in the femur is important for surgeons and other healthcare professionals involved in the diagnosis and treatment of fractures and other conditions affecting the femur.

Keyword: Foramen, Femur, Bone

Introduction

The study of nutrient foramina is important in both morphological and clinical aspects.
nutrient foramen is an opening on the surface bone which gives entrance to the blood vessels of the medullary cavity of a bone, for its nourishment and growth[(1)]. The role of nutrient foramen innutrition andgrowth of the bones is evident from term “nutrient” itself.

The nutrient artery is the principal source of blood supply to the long bone, and is particularly important during its active growth period in the embryo and fetus, as well as during the early phase

of ossification . Bones adapt to the mechanical environment and contain naturally occurring holes which allow blood vessels to pass through the bone cortex. These blood vessels are compromised especially in childhood due to medullary bone ischaemia with less vascularization of the metaphysis and growth plate.

The study of nutrient foramina is important for both morphological and clinical aspects. Some pathologicalbone conditions such as fractures healing or acute hematogenic os- teomyelitis are closely related to the vascular system of the bone . Detailed data on the blood supply to the long bones is invariably crucial in the development in transplantation development and Orthopaedics resection techniques. An understanding of the position and number of the nutrient foramina in long bones is important in Orthopaedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery so that surgeons could avoid nutrient foramen during an open reduction to improve fracture healing[(2)]. Nutrient foramen is the largest opening on the long bone shaft. The femur may have one or two nutrient foramina along the linea aspera which leads to oblique nutrient canal; if two nutrient foramina are present one appears at proximal end (one end) and other at distal end of linea aspera both being directed proximally. The nutrient artery enters through nutrient foramen, passes through nutrient canal and finally opens into madullary cavity. The artery then divides into marrow sinusoids and finally forms numerous small vessels that ramifies through the cortex, supply bone marrow and spongy bone[(3)]. the study of arterial supply is important as, acute blood vessel occlusion due to thrombosis, lipid emboli, fat cell hypertrophy with compression of intraosseous capillaries (small blood supply), leads to avascular necrosis and bone infarction, whereas osteoporosis results from arteriosclerosis . Four groups of arteries supply a typical long bone - nutrient artery, epiphyseal artery, diaphyseal and periosteal artery . All the nutrient arteries course caudally during embryonic life to force blood from cephalic to caudal side and thus the (adult age) adult rule „towards the knee and away from elbow" become logical as one end of long bone growing faster than the other end . Femoral diaphysis is fed by one or two nutrient arteries arising from profunda femoris artery. Profunda femoris artery can be used in femoral diaphysis transplant surgeries. Currently, the detailed study of blood supply to long bones has been found to be a determining factor for the success of new techniques for bone transplant and resection in Orthopedics . Various morphometric and analytical studies have been done torecord the number, location, direction of nutrient foramina in femur andalso the calculation of foraminal index. However to the best of our knowledge, no study has been found which has made the co-relation between (b/w) Foraminal Index (FI) and the distance of nutrient foramina from fovea (F1), lesser trochanter (F2), and from mid intertrochanteric line/crest (F3Thus, the aim of this study is to observe the detailed features of (small foreman) nutrient foramen in human femur and calculate the indices which would contribute in (medico-legal medico legal cases) cases and bone grafting. This would further help in standar dising the detailed featuresof nutrient foramina in human femur for anthropometric purposes[(4)].

Review of Literature

Seema et al study of 180 long bone under variation in the number and position of nutrient foramina of long bones of lower limb in north Indians. find data 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.

Author	Year	Various numbers of Nutrient foramina in femur (%)			
		One	Two	Three	Absent
Krischener et al	1998	35	57	8	0
Pereira et al	2011	97	40	1.2	0
Prashanta et al	2011	47	44	3.5	4.6
Present study (Total Bone 250)	2022	92.4	7.6	0.4	0

Aims and Objectives

The objective of present study is to know about them orphologyandtopography of nutrient foramen in adult femur. The study has the following sub-objectives-

1. Positions of nutrient foramen and whe ther obey the rule of ossification.
2. Variation of nutrient foramen in femur and the number.
3. Clinical important of nutrient foramen of femur is important in surgical procedures likebone grafting and micro-surgical vascularzed bone transplantation to preserve circulationandfor avoidanceof nutrientarteries damage.

Material and Methods

The study was conducted on the Femur specimens available at the Department of Anatomy, Gouri Devi Institute of Medical Sciences and Hospital and other medical colleges of Bardhaman District . In the present study, 250 cleaned and dried femurs were included and the femur with any signs fracture or deformity was excluded. The side determination of the femur was done and following parameters were observed:

- **Inclusion Criteria:**

- Dry, clean, anatomically and pathologically normal human femur were taken.
- Only well defined nutrient foramina were observed.
- Nutrient foramina only on the shaft of femur were included in the study.

- **Exclusion Criteria:**

- Specific race, age, sex were not studied as observed bones were taken from osteologycollection of dry bones, not from the cadavers.
- Any fractured bone or bones with any other pathological changes were excluded fromour study.
- Nutrient foramina present at the ends of femur were ignored.

- **Total length:** Total length of femur was measured with the help of 500 mm 20” Digital Vernier Caliper Metric. The total length was measured between the proximal part of the head of the femur and the distal aspect of the medial condyle.
- **Number of nutrient foramina**: The nutrient foramen of the femur was identified by the presence of well- marked groove leading to it and a well-marked ridge proximal to it. Weobserved the number of nutrient foramina with the help of hand lens.
- **Location of nutrient foramen:** The location of foramen in relation to specific borderand surface was noticed.
- **Directions of the nutrient foramina:** A straight wire was used to find the direction ofthe nutrient canal. They were recorded as directed towards the proximal or distal ends.
- **Distance of foramina:** The distance of the foramen from the proximal end was recordedwith the digital vernier caliper and recorded to nearest 0.1mm. In femur with double or triple nutrient foramina, the distance of all foramina from the proximal end were measured.
- **Foraminal Index:** The Foraminal Index was calculated to determine the exact locationof the foramen in relation to the length of bone using Hughes formula:

FI = D/L x 100

Where,
FI = Foraminal Index
L = Total length of the bone
D = Distance of the foramen from the proximal end Foraminal Index was divided asfollows: All the data were entered in Statistical Package for Social Sciences (SPSS)version 16 and frequency and percentage were calculated under department of community medicine, GIMSH, Durgapur, Bardhaman, West-Bengal.

For 156 Right Femur Bone

Measurements	Mean	Stander Deviation
Length (N=156)	**40.7**	**3.00**
Distance Between the Nutrient Foramen and Superior border of greater trochanter (n=74)	**15.87**	**2.37**
Antero-posterior diameter at the level of nutrient foramen (n=74)	**2.53**	**0.21**
Lateromedial diameter at the level of nutrient foramen. (n=74)	**2.67**	**0.12**

For 94 Left Femur Bone

Measurements	Mean	Stander Deviation
Length (N=94)	**41.22**	**2.69**
Distance Between the Nutrient Foramen and Superior border of greater trochanter (n=97)	**15.72**	**2.07**
Antero-posterior diameter at the level of nutrient foramen (n=97)	**2.54**	**0.16**
Lateromedial diameter at the level of nutrient foramen. (n=97)	**2.53**	**0.14**

Out of 250 femur bone (Right side 156 and left side bone 94) of the nutrient foramina in the long bones of lower limb are located on the posterior surface of the boneie 90 % in femur. The average length of the right femur was 40.7 mean value. Average length of the left femur was 41.22 mean value .Nutrient foramen was located on the linea aspera in 77.50 % of cases.

Discussion

Old study with new studies comparison:-

Author	Year	Various numbers of Nutrient foramina in femur (%)			
		One	Two	Three	Absent
Krischener et al	**1998**	**35**	**57**	**8**	**0**
Pereira et al	**2011**	**97**	**40**	**1.2**	**0**
Prashanta et al	**2011**	**47**	**44**	**3.5**	**4.6**
Present study (Total Bone 250)	**2022**	**92.4**	**7.6**	**0.4**	**0**

Showing the number of nutrient foramina in femur bone of burdhwan district of Westbengal State

Bone		Bone showing single foramen		Bone showing two foramen		Bone showing three foramen	
		Number	Percentage	Number	Percentage	Number	Percentage
Femur	**Right (156)**	**138**	**88.46**	**18**	**11.53**	**00**	**00**
	Left (94)	**92**	**97.87**	**1**	**1.06**	**1**	**1.06**

The present study showed single nutrient foramen in femur in Right Side 88.46 % and Left Side 97.87 % of cases as shown by Mysorekar (50%), Sendemir and Cimen [9] (46%), Prashanth et al (47.7%) and Collipal et al[0] (44%)but Pereira et al showed as high as 97.4% of cases. The double nutrient foramina were found in Right side 11.53 % and Left Side 1.06% of cases as shown by Pereira et al. Mysorekar[8]; 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. Cimen[9]; Gumusburun et al[10] but it was less than noted by Campos et al (75%), Kizikanat et al[11](60%). 00 % Right side and Left 1.06 % of the bones showed three nutrient foramina but Campos et al and Gumusburun et al[10] showed incidence as high as 10%. No case of absent nutrient foramen was found. It was in agreement with Sendemir and Cimen 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 . Mysorekar. Next most common position of the nutrient foramen was on the medial (18.50) and lateral surface(5%) as given by Collipal et al. No case was found with the nutrient foramen present on the anterior surface as shown by Sendemir and Cimen.

Conclusion

The present study (250 femoral bone of GIMSH Durgapur) provides the information regarding the position and number of nutrient foramina in femur of lower limb in Burdhwan district of Westbengal population 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 wit medico legal cases.

Summary

The present study 250 femoral bone of burdwan district of Westbengal Population studies showed single nutrient foramen in femur in Right Side 88.46 % and Left Side 97.87 % of cases. The double nutrient foramina were found in Right side 11.53 % and Left Side 1.06% of cases.

Showing the summary with number of nutrient foramina in femur bone of burdhwan district of Westbengal State

Bone		Bone showing single foramen		Bone showing two foramen		Bone showing three foramen	
		Number	Percentage	Number	Percentage	Number	Percentage
Femur	Right (156)	138	88.46	18	11.53	00	00
	Left (94)	92	97.87	1	1.06	1	1.06

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