Diaphysial Nutrient Foramina In Long Bones And Miniature Long Bones

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Abstract : Background: Nutient foramen is an opening into the bone shaft which gives passage to the blood vessels of the medullary cavity of a bone. The knowledge of nutrient foramen is important in surgical procedures like bone grafting and more recently in microsurgical vascularised bone transplantation. Aim: to determine the number, direction, position of nutrient foramen and whether the nutrient foramina obey the general rule that is, directed away from the growing end of the bone. Materials and methods: The present study has been undertaken to review 1000 long bones including clavicle and miniature long bones. Results 6.8% of bones showed no foramen while 10% of bones had double foramen. Conclusion: Majority of the bones followed the growing end theory. Clavicle showed more variation as to the surface on which nutrient foramen was present. None of the earlier workers have done compiled study of all types of long bones in a single study.

Key-words: Diaphysial Nutrient Foramina, Long Bones,Miniature Long Bones

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INTRODUCTION: The role of nutrient foramen in nutrition and growth of the bones is evident from term “Nutrient” itself. Knowledge of position of nutrient foramen can be useful in certain surgical procedures. Their probable role in few cases of vascular necrosis is pointed out[1].The nutrient artery[2,3] is the principal source of blood to a long bone particularly during its active growth period. Because the artery to the shaft of the long bone is the largest it is called the “Nutrient Artery”. Nutrient canal (through which nutrient artery enters the shaft) typically become slanted during growth, the direction of slant from surface to marrow cavity points towards the end that has grown least rapidly. This is due to greater longitudinal growth at the faster growing end. All long bones including clavicle have two epiphysial ends while miniature long bones have only one growing end. The direction of nutrient foramen of all bones is away from growing end.

Importance of nutrient foramen is relevant to fracture treatment. Combined periosteal and medullary blood supply to the bone cortex helps to explain the success of nailing of long bone fractures particularly in the weight bearing like femur and tibia and uses of vascularised fibula bone in bony defects due to trauma.

MATERIAL AND METHODS: A study of 1000 long bones was undertaken. The samples were taken from various medical colleges of Gujarat. The long bones included 100 each of Femur, Tibia, Fibula, Humerus, Radius, Ulna, Clavicle and 30 each of metacarpals and metatarsals.

In all these bones after determining the side of bone, the nutrient foramina were studied in regards with

1. The number of foramina on the shaft of bone
2. Surface on which it was located
3. Direction from growing end
4. Location in relation with length of the shaft

The nutrient foramina were distinguished by the presence of a well marked grove leading to the foramen, and by a well marked often slightly raised edge of the foramen at the commencement of the canal. In doubtful cases a dissecting microscope was used to locate the foramen. For direction of canal fine stiff wire was passed through the foramen to confirm its direction.

RESULTS: Result is tabulated in following table

Table: 1: STUDY OF NUMBERS OF FORAMEN IN 1000 LONG BONES

	Number of Foramina						
	0	1	2	3	4	5	7
Metacarpals and Metatarsals (Total 300)	24	250	25	01	00	00	00
Clavicle (100)	01	68	21	08	02	00	00
Long Bones (Total 600)	43	474	59	18	03	01	01
TOTAL	68	792	105	27	05	01	01
Percentage	6.8	79.2	10.5	2.7	0.5	0.1	0.1

Table 2 : STUDY OF DIRECTION OF FORAMEN IN 1000 LONG BONES

Name of Bones	Figures indicate the number of bones	
	Towards the growing end (1.3%)	Away from the growing end (91.9%)
Metacarpals & Metatarsals(300)	00	276
Clavicles (100)	00	99
Long Bones of the limbs (600)	13	544
TOTAL	13	919
Percentage	1.3	91.9

Table 3 : LENGTHWISE DISTRIBUTION OF FORAMINA ON THE SHAFT OF LONG BONES

No	Name of Bone	(Figures indicate numbers of foramen)		
		Upper Third	Middle Third	Lower Third
1	Femur	86	59	22
2	Tibia	101	01	01
3	Fibula	04	74	09
4	Humerus	09	86	36
5	Radius	76	12	00
6	Ulna	76	18	00
	Total	352	250	68
	Percentage	58.6%	41.6%	11.3%
7	Clavicle	Medial Third 12	84	Lateral Third 46

Table 4 : LOCATION OF FORAMEN ON VARIOUS SURFACES OF SHAFT OF LONG BONES

No	Name of Bone	(Figures indicate number of foramina)		
		Expected site	Variant Site	
			1	2
1	Femur	Medial side of Linea aspara	Lateral side of linea aspara	Anterior Surface
		148 (88.6%)	11 (6.5%)	8 (4.7%)
2	Tibia	Posterior or Postero Lateral -	Lateral Surface	
		101 (98.0%)	2 (1.9%)	
3	Fibula	Posterior Surface	Medial Surface	Lateral Surface
		079 (90.8%)	6 (6.8%)	2 (2.2%)
4	Humerus	Antero-Medial surface	Spiral Groove	Antero-Lateral Surface
		105(80.1%)	24(18.3%)	2 (1.5%)
5	Radius	Anterior surface	Posterior surface	
		083 (94.3%)	5 (5.6%)	
6	Ulna	Anterior surface	Posterior surface	
		093 (98.9%)	93 (1.06%)	
7	Clavicle	Inferior surface	Posterior surface	Superior surface
		60 (42.25%)	80 (56.3%)	2 (1.4%)

Fig 1: A Clavicle showing a foramen on its Posterior Surface

Table 5 : STUDY OF FORAMEN IN MINIATURE LONG BONES

	Figures indicate number of bones					Figures indicate number of foramen						
	Direction of foramen		Number of foramen			Relation of foramen with surface				Lengthwise distribution		
Type of bones 30 each	Towards Upper End	Towards Lower End	0	1	2	Medial	Lateral	Palmer Planter	Dorsal	Proximal Half	Midway	Distal Half
1st Metacarpal	23	00	07	23	00	22	00	01	00	15	07	01
2nd Metacarpal	00	23	07	22	01	13	10	01	00	03	10	11
3rd Metacarpal	00	29	01	27	02	09	18	04	00	00	03	28
4th Metacarpal	00	30	00	26	04	06	24	03	01	03	03	23
5th Metacarpal	00	30	00	30	00	00	30	00	00	01	11	19
1st Metatarsal	28	00	02	24	04	01	24	07	00	28	01	03
2nd Metatarsal	00	27	03	27	00	06	19	00	02	00	08	19
3rd Metatarsal	00	28	02	25	03	08	24	00	00	00	09	22
4th Metatarsal	00	28	02	23	05	16	14	00	03	00	09	24
5th Metatarsal	00	30	00	26	01	26	01	04	07	00	10	28

Fig -2: A humerus with a foramen in spiral groove

Fig -3: Foramen of tibia is directed towards the knee

DISCUSSION: There is a jingle for the direction of nutrient foramen "seeks the elbow and flees the knee"[2]. That is foramen are directed towards elbow in upper limb (directed towards lower end of humerus and upper ends of radius and ulna),while in lower limb nutrient foramen is directed away from knee(that is, upper end for femur and lower ends of tibia and fibula) This is said to be due to one end of limb bones growing faster than the other. The present study confirms this (table 1). Only 1.3% of limb bones defied the growing end theory. The only probable explanation could be that there must not have been much difference in the longitudinal growth of bone at both the ends. All clavicles, metacarpals and metatarsals obeyed growing end theory. This is in accordance with the previous studies(5-10). In the present study 6.8% of long bones had no nutrient foramen, the maximum incidence was in fibula (16%) followed by femur. Humerus showed absence of foramen but in lesser proportions. Again fibula showed maximum variation in direction of nutrient canal i.e. towards the growing end. Both the percentages of variation are higher than previous studies4-9. Position of foramen was different in clavicle i.e. on posterior surface. This finding is different from most of the texts.

CONCLUSION: We can conclude from present study that, Out of the 1000 bones studied

1. 79.2% bones had single foramen, 6.8% bones had no nutrient foramen. This suggests that in case of obliteration of nutrient foramen the epiphysial artery might have taken up the charge of supplying the bone.
2. The location of the foramina on the surface of the shaft correlates with the expected site except clavicle where it was seen on posterior surface than the expected inferior surface.
3. For miniature long bones the direction was away from the growing end without any exception.

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