International Journal of Anatomy and Research,
Int J Anat Res 2018, Vol 6(4.2):5848-52. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2018.359

Original Research Article

NUTRIENT FORAMINA ARCHITECTURE IN METACARPAL AND METATARSAL BONES

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ABSTRACT

Nutrient foramen (NF) conducts blood vessels which are chief nutritional source to bones. The anatomical knowledge of nutrient foramina plays vital role in certain operative procedures to preserve the circulation. Details of NF in metacarpals and metatarsals is essential in reconstruction surgeries. This study designed to assess the architecture of nutrient foramina over metacarpal and metatarsal shafts. For this, a total 400 metacarpal and 400 metatarsal bones were collected. All bones are examined for details of number, position, location and direction of nutrient foramina on shaft. Foraminal index was calculated by using Hughes formula. Majority bones are having single nutrient foramen (79.7% metacarpals, 79.5% metatarsals), double nutrient foramina was situated in very few metacarpals and metatarsals. Nutrient foramina are situated over medial surface of 1st & 2nd metacarpals and 4th &5th metatarsal bones, whereas other bones have nutrient foramina over lateral surface of shaft. The anatomical and morphological details of nutrient foramina is beneficial for orthopedic and plastic surgeries during vascularized bone microsurgery and in bone grafts.

KEY WORDS: Nutrent foramen (NF), Metacarpals, Metatarsals, Faraminal Index (F.I).

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2018.359	**Article Information** Received: 14 Aug 2018 Accepted: 03 Oct 2018 Peer Review: 16 Aug 2018 Published (O): 05 Nov 2018 Revised: None Published (P): 05 Nov 2018

INTRODUCTION

The metacarpals of hand skeleton and metatarsals of foot skeleton are termed as short or miniature long bones with inbuilt longitudinal and collective transverse arch. They differ from other long bones by having single epiphysis at only one end [1].

The metacarpals and metatarsals are chiefly supplied by nutrient artery along with periosteal and epiphyseal arteries. Being chief nutritional support to the bone, it plays key role in healing and union of fractures [2]. Nutrient artery transmits through nutrient foramen. Knowing about nutrient artery is essential for surgeons to preserve vessels in free vascularized bone grafts, which is essential to promote fracture repair and for the survival of osteocytes and osteoblasts [3].

The anatomical knowledge about nutrient foramina is useful in orthopedic surgeries, bone grafts, vascularized bone microsurgery, transplantations and reconstruction of fractured sites [4]. Several studies reported details of nutrient foramen in metacarpals and metatarsals separately. Due to the literature gap this study was designed to assess the architecture of nutrient foramen in metacarpal and metatarsal bones included their number, position, direction and foraminal index.

MATERIALS AND METHODS

For the present study a total 400 metacarpal and 400 metatarsal bones were collected from Department of Anatomy of MNR Medical College and Hospital, Sangareddy and Maheshwara Medical College, Patancheru, Telangana. Bones with fractures, grossly pathological, abnormal and malformed bones were excluded from the study.

All the collected bones were examined for

1. Number of nutrient foramina

2. Position of nutrient foramina on shaft - medial and lateral surface

3. Distance of nutrient foramina from the base of bone.

4. Direction of nutrient foramina.

Vernier's caliper was used to measure the length of bones and to ensure the direction of nutrient foramina thin needle was used. Alone, Diaphyseal nutrient foramina through which main nutrient artery passes were studied. Epiphyseal and other vascular foramens were not considered. Forminal index was calculated by Hughes formula [5].

Foraminal index = D/L X 100

*D = Distance of nutrient foramina from base of the bone.

*L = Total length of bone.

Table 1: Total number of nutrient foramina over the shaft of long bones.

Bone		Metacarpals					Metatarsals				
		1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Total bones studied	Rt.	40	40	40	40	40	40	40	40	40	40
	Lt.	40	40	40	40	40	40	40	40	40	40
Number of foramina	0	2	9	5	8	4	4	2	2	1	4
	1	68	57	66	65	63	55	69	63	67	64
	2	10	14	9	7	13	21	9	15	12	12

Fig. 1: Location of nutrient foramina over the shaft of metacarpal bones.

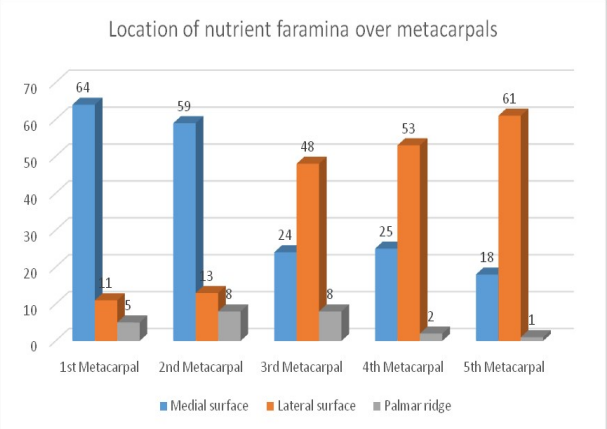

Fig. 2: Location of nutrient foramina over the shaft of metatarsal bones.

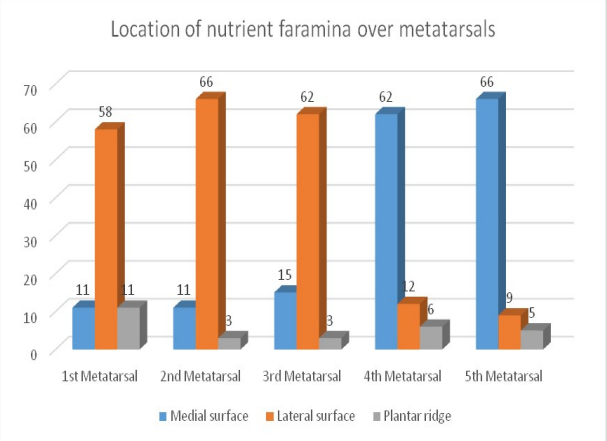

Table 2: Position of nutrient foramina over proximal, middle and distal parts of shaft of the metacarpals and metatarsals.

Bone		Metacarpals					Metatarsals				
		1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Position of foramina over shaft	P1/3	7	6	14	12	3	4	16	12	5	3
	M1/3	67	70	59	65	76	62	62	60	73	73
	D1/3	6	4	7	3	1	14	2	8	2	4
Grand total		80	80	80	80	80	80	80	80	80	80

*P1/3= Proximal 1/3, M1/3 = Middle 1/3, D1/3 = Distal 1/3.

Table 3: Range of Foraminal index (F.I) in metacarpal and metatarsal bones.

Bone	Metacarpals					Metatarsals				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Range of Foraminal index	29.2-74.5	28.4-78.8	27.7-78.3	27.1-76.8	26.5-79.9	25.1-73.6	28.2-70.7	30.1-81.3	29.9-72.2	28.6-75.4

DISCUSSION

The nutrient artery is a dominating blood vessel which supply major entity of a long bone along with diaphyseal, periosteal and epiphyseal arteries [6]. The nutrient foramen is referred as an external opening of nutrient canal and is lied on the flexor aspect of bony shaft. The actual site of nutrient foramen is related to main center of ossification because corresponding nutrient vessels arises from the initial invasion of the ossifying cartilage [7-9]. In foetal life, nutrient foramen directed horizontally due to

parallel growth at the two ends before epiphyseal appearance [10]. Currently, periosteal slip theory of Schwalbe and vascular theory of Hughes are widely accepted. For this study, 400 metacarpal and 400 metatarsal bones of both sides and both sexes were considered and assessed for nutrient foramen architecture over shaft.

Number of nutrient foramina: In this study, more number of 2nd & 5th metacarpals and 1st & 3rd metatarsals are showed two nutrient foramina over shaft than other bones. On average 63.7 bones showed single nutrient foramina over their shaft. (Table 1). Absence of nutrient foramen was seen in few bones. In such bones, periosteal artery take a lead and fulfills the sufficient bony needs [11,12]. Patake and Mysorekar, Sharimankar et al., Malukar and Joshi noticed single nutrient foramen over shaft of more number of metacarpal bones [12-14]. Anjali singla et al., in his study found single nutrient foramen over shaft of all five metacarpals [15].

Position and location of nutrient foramina: Study by Patake and Mysorekar, Wood Jones et al., observed that nutrient foramina of 1st & 2nd metatarsals, sometimes 3rd & 4th metatarsals are situated on lateral surface [12,16]. Singh et al., observed that nutrient foramina of 4th metatarsals on their medical surface [17].

In the present study, nutrient foramen of 1st & 2nd metacarpals are located more on medical surface, whereas of 3rd, 4th& 5th, foramina lied over lateral surface. In more number of 1st, 2nd & 3rd metatarsals nutrient foramen are located over lateral surface of shaft, nearly uniform distribution of foramen over medial (40) and lateral (34) surfaces of 4th metatarsals, whereas in 5th metatarsals nutrient foramen are located over lateral surface of shaft. Study by Kumari Sandhya et al., stated that 100% of nutrient foramina lied over lateral surface of 1st metatarsal, whereas in study by Anamica et al., none of the 1st metatarsal showed NF over lateral surface [11,18].

The majority nutrient foramen of all metacarpal and metatarsal bones are posited over middle 1/3 of their shaft.

Fig. 3: Number of nutrient foramina over proximal, middle and distal parts shaft of metacarpal bones.

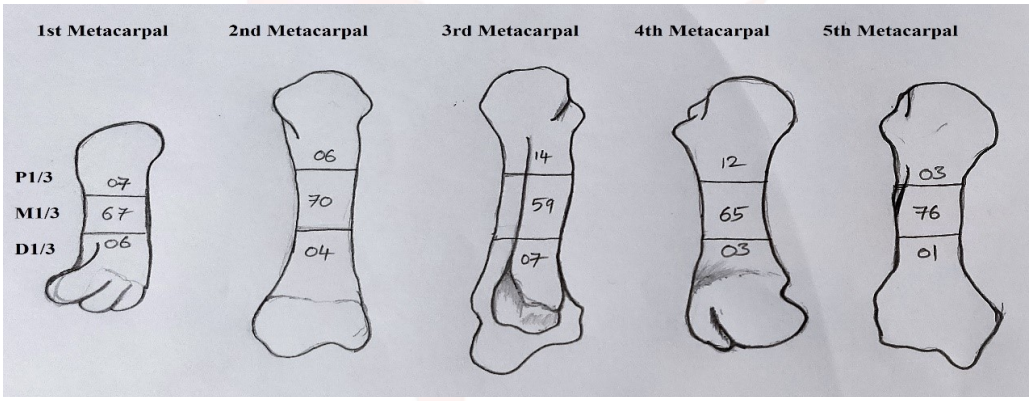

Fig. 4: Number of nutrient foramina over proximal, middle and distal parts shaft of metatarsal bones.

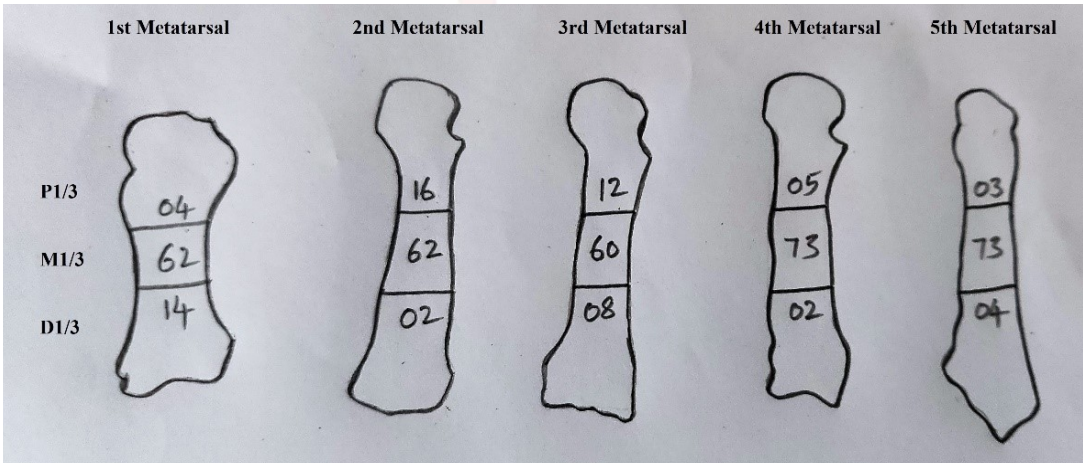

Table 4: Foraminal index Comparison of present with previous studies.

Foraminal Index	Patake & Mysorekar (1977)	Shrimankar et al. (2010)	Anjali Singla et al. (2016)	Anamika K et al. (2017)	Kumari Sandhya et al. (2017)	Present study (2018)
Metacarpals						
1st	40.02-80	59.29	41.7-70.8	-	-	29.2-74.5
2nd	28.3-69.36	47.18	34.9-73.6	-	-	28.4-78.8
3rd	29.41-76.60	41.25	28.6-53.6	-	-	27.7-78.3
4th	20.20-78.40	43.87	30.6-64.4	-	-	27.1-76.8
5th	31.70-63.04	47.48	33.9-63.8	-	-	26.5-79.9
Metatarsals						
1st	30.5-81.66	-	-	65.3	32.78-71.15	25.1-73.6
2nd	25.4-55.55	-	-	43.6	17.91-63.33	28.2-70.7
3rd	31.40-59.1	-	-	44.4	29.57-56.89	30.1-81.3
4th	36.40-62.91	-	-	45.3	30.76-63.33	29.9-72.2
5th	37.3-71.73	-	-	47.5	14.28-49.18	28.6-75.4

Direction of Nutrient canal: In this study, the direction of nutrient canal in all metacarpal and metatarsal bones are opposite to growing end. Malukar O and Hemang Joshi stated that direction of NF of all long bones are always way from the growing end (14).

Foraminal Index (F.I): The range of for Foraminal index in this study and its comparison with previous workers is compared (Table 4).

CONCLUSION

The knowledge about position and architectures of nutrient foramen is essential for the surgeons to perform vascular and reconstruction surgeries. The study results concluding that majority bones are having single nutrient foramen, double nutrient foramina was situated in very few metacarpals and metatarsals. Nutrient foramina are situated over medial surface of 1st &2nd metacarpals and 4th &5th metatarsal bones, whereas other bones are having majority nutrient foramina over lateral surface of their shaft. The direction nutrient canal followed the growing end theory of the nutrient artery i.e. away from the growing end.

Conflicts of Interests: None

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How to cite this article:

Jyothinath Kothapalli. NUTRIENT FORAMINA ARCHITECTURE IN METACARPAL AND METATARSAL BONES. Int J Anat Res 2018;6(4.2):5848-5852. **DOI:** 10.16965/ijar.2018.359