

Research Article

Morphologic study of diaphyseal nutrient foramina in dried fibulae and its clinical implications

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ABSTRACT

Background: Fibula is an important site for muscle attachment. It is used as a vascularised graft for conditions such as stabilization of lost mandible, spine and even the tibia. The knowledge of morphological and topographic distribution of nutrient foramina of fibula is important to avoid damage to the nutrient arteries during surgical procedures.

Methods: The study was conducted on 50 adult dried fibulae. Diaphyseal nutrient foramina were identified by their elevated margins and by the presence of a distinct groove proximal to them. Foramen index was calculated.

Results: 90% fibulae showed single nutrient foramen, in 8% of fibulae nutrient foramen was absent and 2% fibulae presented with double nutrient foramina. 95.74% nutrient foramina were directed away from growing end, while 4.54% nutrient foramina were directed towards the growing end. 82.7% nutrient foramina were observed in the middle zone. All the foramina were present on the posterior surface. 48.93% of the foramina were present on the medial crest, 38.29% were present between the medial crest and posterior border. The mean foramen index of all the fibulae studied was 43.73.

Conclusions: The knowledge of nutrient foramina is essential to preserve the vascularity of bone. This study aids the clinician in fracture reductions and bone grafting.

Keywords: Fibula, Diaphyseal nutrient foramina, Foramen index, Bone graft

INTRODUCTION

Fibula is an important site for muscle attachment and significant source of bone graft.¹ Fibular vascular graft is used for stabilization of mandible, spine and even the tibia.² Long bones are supplied by a diaphyseal nutrient artery that enters the bone through a foramen called nutrient foramen.³ Nutrient foramina reflect the degree of bone vascularity.⁴ Regarding the direction of nutrient foramen, it is stated that they seek the elbow and flee from knee.⁵ This blood supply is essential during the growth period, during early phase of ossification congenital pseudoarthrosis, in procedures like bone

grafts, tumour resection, traumas, and in transplant techniques.¹ The fibula reverses the ossification pattern in respect to other long bones.¹ Neurovascular injury, weakness of extensor hallucis longus and instability of ankle might occur as a complication of fibular graft.⁵ The knowledge of morphological and topographic distribution of nutrient foramina of fibula is important to avoid damage to the nutrient arteries during surgical procedures. The present study is aimed to enhance the morphologic knowledge of the diaphyseal nutrient foramen in fibulae by analysing the number, location and direction of the nutrient foramina in fibulae obtained from the region of coastal Karnataka.

METHODS

The study was conducted on 50 adult dried fibulae (30 right and 20 left). The dried fibulae were obtained from the students and from the osteology section of Anatomy department, Father Muller Medical College, Mangalore, India. The damaged bones and those with gross pathological deformities were excluded from the study. After side determinations, the nutrient foramina were observed in all bones. Elevated margin around the foramina and a groove proximal to the foramina were used for identification of nutrient foramen. Foramina at the ends of the bone were ignored.

Bone length was determined by placing the bone on osteometric board. The distance between the upper and lower end was recorded.

Nutrient foramina were studied with respect to number, size, position in relation to the surface of the shaft and direction. Nutrient foramina smaller than the size of 24 gauge hypodermic needle were considered as secondary foramina and were not included for the study. The direction and obliquity of the foramen was confirmed by passing a fine stiff wire. The distance of nutrient foramina from the upper end was noted by placing the bone on the osteometric board.

Foramen index (FI) was calculated using Hughes formula.⁶

$$FI = (DNF / TL) \times 100.$$

- Where, DNF: The distance between the nutrient foramen and proximal end of the bone.
- TL: Total bone length.

RESULTS

Out of the 50 dried fibulae studied (right 30, left 20), 45 (90%) showed single nutrient foramen, in 4 (8%) fibulae nutrient foramen was absent, 1 (2%) fibula presented with double nutrient foramina (Table 1). Of the 47 DNF observed (27 on right and 20 on left), 45 (95.74%) nutrient foramina were directed away from growing end, while 2 (4.54%) nutrient foramina were directed towards the growing end (Table 1, Figures 1 and 2). Out

of 47 diaphyseal nutrient foramina (DNF) observed, 39 (82.7%) nutrient foramina were found in the middle zone, 5 (10.63%) nutrient foramina were found in the upper 1/3rd and 3 (6.38%) nutrient foramina were observed in lower 1/3rd (Table 2 and Figure 3).

Table 1: Number of nutrient foraminae observed in all fibulae.

Side	No of fibulae	No of foramina			Direction of foramina	
		0	1	2	Towards growing end	Away from growing end
Right	30	3	27	0	2	25
Left	20	1	18	1	0	20
Total	50	4	45	1	2	45

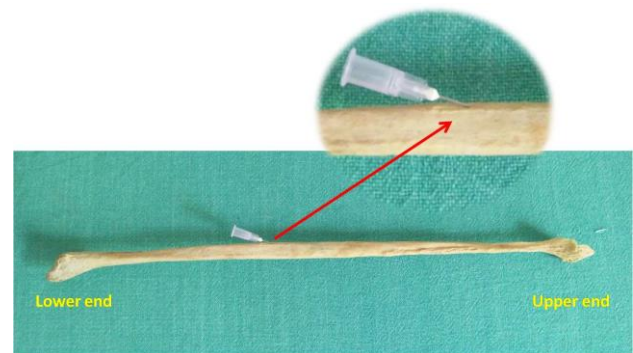


Figure 1: DNF directed towards the upper end.

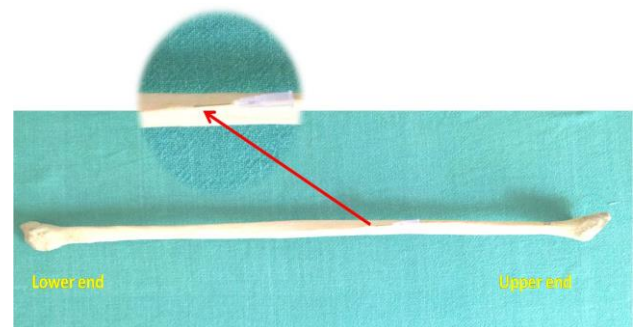


Figure 2: DNF directed towards the lower end.

Table 2: Distribution of diaphyseal nutrient foramina on the shaft of fibulae.

Side	Number of fibula	No of foramina	Lengthwise distribution	Number	%
Right	30	27	Upper 1/3	2	7.4%
			Middle 1/3	25	92.59 %
			Lower 1/3	0	0
Left	20	20	Upper 1/3	3	15%
			Middle 1/3	14	70%
			Lower 1/3	3	15%
Total	50	47	Upper 1/3	5	10.63%
			Middle 1/3	39	82.97%
			Lower 1/3	3	6.38%

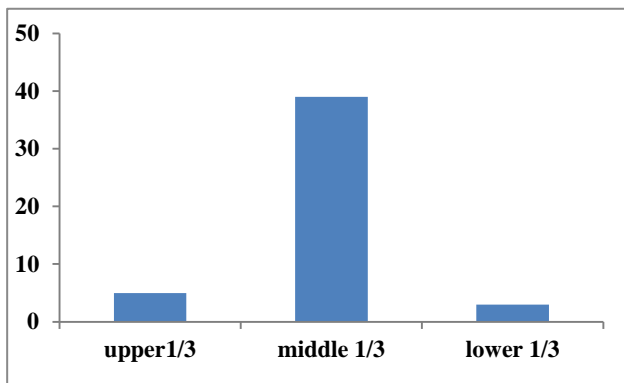


Figure 3: Lengthwise distribution of nutrient foramina on the shaft of fibula.

Table 3: Distance of nutrient foramina from the upper end of fibula and total bone length.

Side	No of bone	Distance (in cm) of DNF from the upper end		Total bone length (in cm)		FI	
		Mean	SD	Mean	SD	Mean	SD
Right	30	16.62	2.82	35.8	2.72	46.41	7.44
Left	20	16.22	3.4	35.68	2.2	45.26	8.78
Total	50	17.7	4.27	40.5	4.69	43.73	9.69

Table 4: Distribution of nutrient foramina on the posterior surface of fibula.

Side	No of fibulae	No of foramina on the posterior surface of fibula			Total no of foramina
		On the medial crest	Between interosseous border and medial crest	Between medial crest and posterior border	
Right	30	14	5	8	27
Left	20	9	1	10	20
Total	50	23	6	18	47

DISCUSSION

In the present study 45 (90%) fibulae showed single nutrient foramen, 1 (2%) fibula showed double nutrient foramina and 4 (8%) fibulae showed absence of nutrient foramina. The results correlate with the studies of Murlimanju et al. 7 who reported 90.2% fibulae with single foramen and 9.8% fibulae with absent foramina and Sharma et al. who observed 92% fibulae with single nutrient foramen and 8% fibulae with absent nutrient foramina. In a study by Patel et al., 80% of fibulae had single foramen and the remaining 20% had double foramina.^{8,9}

In our study, 45 (95.74%) foramina were directed away from the growing end, 2 (4.25%) foramina were directed towards the growing end. Rakesh Gupta et al. reports 20.30% of foramen directed towards growing end, which is contrary to the belief that nutrient artery runs away from the growing end. Malukar et al. studied 1000 long bones and observed maximum variation in the direction of nutrient canal in fibula. i.e. towards the growing

end.^{5,10} Patel Satish et al. reports 77.71% fibular nutrient foramina directed distally and 22.22% directed proximally.¹

All the nutrient foramina were found on the posterior surface. 23 (48.93%) foramina were present on the medial crest, 18 (38.29%) were present between the medial crest and posterior border and 6 (12.76%) foramina were present between the interosseous border and medial crest (Table 4).

Table 3: Distance of nutrient foramina from the upper end of fibula and total bone length.

Side	No of bone	Distance (in cm) of DNF from the upper end		Total bone length (in cm)		FI	
		Mean	SD	Mean	SD	Mean	SD
Right	30	16.62	2.82	35.8	2.72	46.41	7.44
Left	20	16.22	3.4	35.68	2.2	45.26	8.78
Total	50	17.7	4.27	40.5	4.69	43.73	9.69

Table 4: Distribution of nutrient foramina on the posterior surface of fibula.

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		On the medial crest	Between interosseous border and medial crest	Between medial crest and posterior border	
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Total	50	23	6	18	47

end.^{5,10} Patel Satish et al. reports 77.71% fibular nutrient foramina directed distally and 22.22% directed proximally.¹

In the present study, 82.97% of the foramina were found on the middle 1/3rd, 10.63% were found on the upper 1/3rd and 6.38% were found on the lower 1/3rd of the shaft. The results correlate with study of Gupta R et al., which states that 81.95% foramina were located in middle 1/3rd of fibulae, 9.02% in upper 1/3rd and 9.02% in lower 1/3rd.⁵ Gumusburun et al. studied 60 fibulae and found that 92.3% of foramina were located in middle 1/3rd of fibulae. McKee et al. also found 96% foramen located in middle 1/3rd of fibulae.¹²

The mean bone length on right side was 35.8±2.72 cm, while on left side it was 35.68±2.2 cm. The mean foramen index was 43.73. Kamath et al. reported the mean foramen index in fibula to be 44.60, While Murlimanju et al., reported it to be 49.2.^{3,7}

In our study the entire nutrient foramina were found on the posterior surface. This correlates with the study of Kamath et al who reported 100% of the nutrient foramina on the fibular posterior surface.³

In the present study, 23 (48.93%) foramina were present on the medial crest, 18 (38.29%) were present between the medial crest and posterior border and 6 (12.76%) foramina were present between the interosseous border and medial crest. Satish P et al. reports 66.6% to be on the medial crest of the posterior surface, 30.5% on the posterior surface between interosseous border and medial crest and 2.7% on lateral surface.¹

CONCLUSION

Knowledge about the foramen topography is useful during surgical procedures to preserve bone vasculature. Adequate dissection around the location of the nutrient foramen allows harvesting the fibular graft with minimum incision. This study about the morphology of nutrient foramen in fibula from population of coastal Karnataka may prove helpful for comparison with other groups.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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