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THE MORPHOLOGICAL ANATOMY OF NUTRIENT FORAMEN IN DRY HUMAN TIBIA WITH ITS CLINICAL IMPLICATIONS

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ABSTRACT

Background: Tibiae are supplied by a nutrient artery that enters individual bones obliquely through a nutrient foramen. The nutrient foramen of the tibia is the largest and is most often located on the posterior surface of proximal third the tibia.

Methods: The present study was conducted on 48 (right 25and left 23) adult dry tibia. Number, direction and distribution of the nutrient foramina were observed by using a hand lens and a fine needle.

Results: Most of the nutrient foramina are single, downward and present on posterior surface of tibia which almost coincide with studies. In 93.8% tibia shows single nutrient foramen and 6.2% tibia have double nutrient foramina and most of the nutrient foramina are downward 96.1%, only few foramina upward in direction 3.9%.

Conclusions: The morphological knowledge about the nutrient foramen is essential to proceed bone grafting used for mandibular reconstruction and dental implants. The anatomical details about the nutrient foramen are required to the operating surgeon.

Key words: nutrient foramina, tibia, single, posterior surface

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INTRODUCTION

Long bones are supplied by a nutrient artery that enters individual bones obliquely through a nutrient foramen. In the majority of cases nutrient foramina is located away from the growing end[1]. In tibia, nutrient foramen is generally directed downwards because upper end is growing end, as it fuses with shaft in the 16th year in females and in the 18th in males. While lower end fuses with the shaft at about 15th year in females and 17th year in males[2]. In young age the long bones primarily receive about 80% of its blood supply from the nutrient arteries and in the absence of these arteries the vascularisation occurs through the periosteal vessels.[3]

The nutrient foramen of the tibia is the largest and is most often located on the posterior aspect of the tibia where a large vascular groove present near the end of the vertical line which is a faint line descend- ing from the centre of the soleal line and directed distally.

The morphological and anatomical knowledge of nutrient foramina is significantly important for orthopedic neurovascular surgeons undertaking an open reduction of a fracture to avoid injuring the nutrient artery and thus lessening the chances of non- union of the fracture.[4]

The tibia is the most commonly fractured long bone and the fracture of the tibia through the nutrient canal disrupts the blood flow in the nutrient artery thus contributing delayed union and non-union of the bone. Knowledge of the blood supply and location of nutrient foramen is important in the treatment planning of surgery in fracture. The success of nailing of long bone fractures chiefly in the weight bearing bones like the femur and tibia is explained by the periosteal and medullary blood supply to the bone cortex.

The location and the number of the nutrient foramina in long bones is vital in various orthopaedic surgical procedures like joint replacement therapy, fracture repair, bone grafts and vascularized bone surgery. In bone grafts the nutrient blood supply is crucial and must be preserved to promote fracture repair. During preoperative angiography it is important to exclude the possible vascular anomalies in both recipient and donor bones for the micro vascular bone grafts[5].

The aim of the present study is to deter- mine the number, position, direction of the nutrient foramina in human tibia to help doctors of various disciplines including anatomy, orthopedics and surgery.

MATERIAL AND METHODS

The present study was conducted on 48 (right 25and left 23) adult dry tibia of unknown age and sex examined in Department of Anatomy, Government Medical College, Sri Ganganagar, Rajasthan. Fully ossified and complete bones were included and bones with pathological changes or any kind of deformity or damage were excluded from the study. Nutrient foramen was identified by presence of a well-marked groove and a raised margin at its beginning and its direction were determined by

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passing the needle into the foramen. Number, direction and distribution of the nutrient foramen was carefully observed by using a magnifying hand lens and then passing a fine needle through the foramen to confirm its patency and direction.

The following measurements were taken using hand lens and fine needle.

(1) Number of nutrient foramina on each tibia (single/double)

(2) Direction of the nutrient foramina (downward/upward)

(3) Position of nutrient foramina in tibia (upper/middle/lower third)

(4) Location of nutrient foramen in reference surface (posterior/medial/lateral)

(4) Location of nutrient foramen in reference to the vertical line

The observations were recorded and tabulated. The morphometric values were subjected to statistical analysis.

RESULTS

In the present study 25 bones of the right and 23 bones of the left were evaluated. In the right side 26 nutrient foramina were observed and in left side 25 nutrient foramina were found.

Table 1: Showing the morphological distribution of the nutrient foramina in tibia

Nutrient foramina	No of nutrient foramina		Total no of foramina	Percentage
	Right	Left		
Single	24	21	45	93.8
Double	1	2	3	6.2
Downward	25	24	49	96.1
Upward	1	1	2	3.9

Table 1 shows single nutrient foramen present in 93.8% of tibia, double nutrient foramina present in 6.2% of tibia and most of the nutrient foramina are downward 96.1%, only few foramina upward in direction 3.9%.

Table 2: Showing lengthwise distribution of nutrient foramina in tibia

Side	Number of tibia	Number of nutrient foramina	Lengthwise distribution	Number	Percentage
Right	25	26	Upper 1/3	23	88.5
			Middle 1/3	3	11.5
			Lower 1/3	0	0
Left	23	25	Upper 1/3	24	96
			Middle 1/3	1	4
			Lower 1/3	0	0
Total	48	51	Upper 1/3	47	92.2
			Middle 1/3	4	7.8
			Lower 1/3	0	0

Table 2 shows 92.2% nutrient foramen present on the upper third of the tibia and 7.8%present on middle third of the bone. There were no foramina in the lower third of the bone in our study.

Table 3: Showing the location of nutrient foramina in relation to vertical line of tibia

Location of nutrient foramina	Right	Left	Total
Lateral to vertical line	24	24	48
Medial to vertical line	1	1	2
On vertical line	1	0	1
Posterior surface	24	23	47
Medial surface	2	1	3
Lateral surface	0	1	1

Table 3 shows most common position of nutrient foramina was found lateral to vertical line which was 48 and only 2 tibia had nutrient foramina medial to vertical line and 1 tibia on vertical line. Among 51 nutrient foramina, most of the nutrient foramina present on posterior surface (47), only few foramina present on medial and lateral surface of tibia.

DISCUSSION

The morphological knowledge of nutrient foramina is significantly important for orthopaedic surgeons undertaking an open reduction of a fracture to avoid injuring the nutrient artery and thus lessening the chances of delayed union of the fracture13.

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Number of nutrient foramen:

In the present study we observed double nutrient foramen in one right and two left tibia (6.2%) and the remaining tibia (93.8%) showed single nutrient foramen which almost coincide with studies reported by Kirschner et al[6] (93.5% a foramen & 6.5% two foramina), Longia[7] et al (95% a foramen and 5% two foramina), Bhatnagar et al[8] 57 (95%) one foramen and 3 (5%) two foramen) and Tejaswi et al[9] 94.87% one foramen and 1.28% two foramen)

Direction of the nutrient foramen:

In our present study (96.1%) cases the direction of nutrient foramen was directed vertically downwards and 3.9% nutrient foramen directed upwards. In a study conducted by K. Udhaya et al[10] the direction of nutrient foramen were also found to be similar on both sides, majority directed vertically downwards, on right (95.71%) & on left (96.92%). Agarwal et al[11], Vadhel et al[12], Tejaswi et al[9], and Kizilkanat et al[13] reported that the nutrient foramen is directed away from the knee joint. All the previous studies confirmed that the nutrient foramen is directed downwards which coincides with our present study.

Position of the nutrient foramen:

In our study the location of nutrient foramina 23 (88.5%) and 24 (96%) was in the upper third of the shaft and in three right nutrient foramina (11.5%) and one left nutrient foramina (4%) was situated in the middle third of the shaft. This result similar with a study conducted by K. Udhaya et al[10] out of 140 foramina majority of nutrient foramina were found in the upper third 107 foramina (76.42%) {right 60 and left 47 foramina} and remaining 33 foramina (23.57%) in the middle third of tibia {right 13 and left 20}. Bhatnagar et al[8] and Tejaswi et al[9] also found in 57 (90.47%) and 148 (94.9%) of tibiae the foramina was in the proximal third of bone and 6 (9.52%) and 8 (5.1%) of tibiae it was in the middle third of the bone. Seema et al[14] found 99.5 % cases and 0.5 % cases had nutrient foramina at the upper and middle thirds of the shaft. There were no foramina in the distal third of the bone in these studies. The regions with good blood supply are more quickly cured than those with a reduced blood supply. Because of the absence of nutrient foramina in the distal third of the tibia, fractures in that area tend to show delayed union or malunion[15].

In our study, nutrient foramen was observed on posterior surface of shaft of most of the tibia except in four bones. It was located on the lateral surface in one bone and on medial surface of three bones. Most of the authors also have reported the location of foramen on posterior surface in most of the bones. Kamath V et al[16] observed foramen on medial surface in 2.82% of bones. Mysorekar VR[17] found 74% of bones into which foramen was located on posterior surface. In their study on black and white South Africans, Mazengenya P and Feremore MD, reported slightly less occurrence of nutrient foramen on posterior surface, 75.6% and 77.8% respectively[18].

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In our study the location of nutrient foramen was situated on the vertical line one right and 2 was located medial to the vertical line and remaining nutrient foramen 48 were located lateral to the vertical line. In a study conducted by K. Udhaya et al[10], the nutrient foramina in 99 (70.71%) were lying lateral to the vertical line, in 17 (12.14%) the nutrient foramina were lying on the vertical line, 12 (8.57%) were medial to vertical line.

Though our present study coincided with the results of previous studies but have some limitations because we were not considered with age and sex differences during our analysis. As we know that some foramina may get ossified in old age and moreover there might be variations in the gender, we should get a forensic help to identify the age and gender of the bone before analysis. This would suffice and will provide thorough information about variations in age and gender.

CONCLUSION

The morphological knowledge about the nutrient foramen is essential to proceed with the free vascular bone grafting, as these have been used for the procedures like mandibular reconstruction and dental implants. The anatomical details about the nutrient foramen are required to the operating surgeon. The data is helpful for clinicians involved in vascular graft surgeries. This research emphasises the anatomical description of nutrient foramina which is important as microvascular bone transfer is becoming more popular.

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