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Nutrient foramen in tibia – A study in coastal region of Karnataka

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Abstract : *The nutrient foramen (NF) of the tibia is located in the proximal third of its diaphysis. With the objective of complementing the information delivered by other authors, we investigated the location, the number of diaphyseal foramina, the distance and position of the foramina in relation to the length of the bone and the proximal epiphysis and the lateromedial diameter and anteroposterior diameter of the bone at the level of NF. For that purpose, we used 50 adult dry tibia of both sexes from the Anatomy department and museum of Manipal University. The mean length of the right tibia was 373mm, left tibia 387mm. Location of the NF was found over the soleal line in 4/26 (15.38%) left tibia and 3/24 (12.5%) right tibia, medial to the soleal line in 4/26 (15.38%) left tibia and 4/24 (16.66%) right tibia. In all the remaining cases, it was lateral to the soleal line. The NF was located in the upper third of the shaft in 23/26 (88.46%) left tibia and 22/24 (91.66%) right tibia, in the middle third 3/26 (11.53%) left tibia and 2/24 (8.33%) right tibia. Mean of maximum diameter of NF was 0.6mm in left tibia and 0.7mm in right tibia. Mean of lateromedial diameter at the level of NF was 28mm in left tibia and 26mm in right tibia. Mean of anteroposterior diameter of the shaft at the level of NF was 88mm on the left tibia and 92mm on the right tibia. Mean of the distance between NF and the highest point of intercondylar eminence was 130mm in left tibia and 134mm in right tibia. The FI of the right tibia was 35.92 and of the left tibia was 34. This data could be useful as reference for surgical procedures of the lower limb.*
Keywords: *Bones, Diaphysis, Lower limb, Nutrient foramen, Tibia*

I. Introduction

The nutrient arteries, usually one or two in number, vascularize the long bones. In addition to these arteries, the metaphyseal, epiphyseal and periosteal arteries also provide nourishment to the long bones. During young age, long bones primarily receive about 80% of its blood supply from the nutrient arteries, and in their absence, the vascularisation occurs through the periosteal vessels[1]. These nutrient arteries enter the long bones through the nutrient foramen. The NF, in most of the cases is located away from the growing end[2] derivation of the axiom saying that direction of foramina 'towards the elbow I go and from the knee I flee'[3].

Thorough knowledge about the blood supply of long bones is one of the important factors for success of new techniques in bone transplant and resection in orthopaedics [4, 5]. During transplant techniques, the variants of distribution of nutrient foramina guides the operating surgeons to place the graft without damaging the nutrient arteries[6]. The topography of nutrient foramina may differ in its growing and non-growing end, precise understanding of this becomes essential in certain surgical procedures to conserve the circulation[7, 8].

II. Material And Method

The present study was conducted on 50 adult dry tibia of both sexes, obtained from the Anatomy department and museum of Kasturba Medical College, Manipal. The following measurements were taken using digital caliper.

1. Length of the tibia
2. Number of nutrient foramina (primary or secondary). The foramina smaller than the size of a 24 hypodermic needle were considered as secondary foramina [9-11].
3. Location of nutrient foramen with respect to the soleal line (medial/lateral/over), with respect to the shaft of the tibia (Upper/middle/lower)
4. Direction of nutrient foramen
5. Maximum diameter of nutrient foramen
6. The lateromedial diameter of the shaft at the level of nutrient foramen
7. The anteroposterior diameter of the shaft at the level of nutrient foramen.
8. Distance between the nutrient foramen and the highest point of intercondylar eminence.
9. Foramen index (FI) – By applying Hughes formula [12], FI=D/Lx100

III. Results

1. Mean length of the tibia – Of the right tibia was 373 mm, of the left tibia was 387 mm.
2. Number of nutrient foramina (primary or secondary) – 1/26 left tibia showed a double nutrient foramen. Fig. 1. All the remaining left and right tibia showed single nutrient foramen. 7/26 left tibia and 3/24 right tibia showed secondary nutrient foramen. All the remaining showed primary nutrient foramen.
3. Location of nutrient foramen –

i. With respect to the soleal line (medial/lateral/over) – The nutrient foramen in 4/26 left tibia and 3/24 right tibia was located over the soleal line. Fig. 2. In 4/26 left tibia and 4/24 right tibia it was located medial to the soleal line. Fig. 3. In all the remaining tibia it was located lateral to the soleal line. Fig. 4. In one right tibia the nutrient foramen was located on the interosseus border. Fig.5, and in one right tibia it was located on the vertical line.Fig.6.

ii. With respect to the shaft of the tibia (Upper/middle/lower) – 3/26 left tibia and 2/24 right tibia it was situated in the middle 1/3rd of the shaft, in 23/26 left tibia and 22/24 right tibia it was situated in the upper 1/3rd of the shaft.

4. Direction of nutrient foramen – In all the cases (100%), it was directed vertically downwards.
5. Mean of maximum diameter of nutrient foramen – On the left tibia, it was 0.6 mm and on the right tibia it was 0.7 mm.
6. Mean of lateromedial diameter of the shaft at the level of nutrient foramen – On the left tibia it was 28 mm and on the right tibia it was 26 mm.
7. Mean of anteroposterior diameter of the shaft at the level of nutrient foramen – On the left tibia it was 34 mm and on the right tibia it was 34.5 mm.
8. Mean of distance between the nutrient foramen and the highest point of intercondylar eminence – On the left tibia it was 130 mm and on the right tibia it was 134 mm.
9. Foramen index (FI) – The FI of the right tibia was 35.92 and of the left tibia was 34.

IV. 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 or non-union of the fracture[13].

In our study the mean length of right tibia was 373 mm and of the left tibia was 387 mm. In a study conducted by K. Udhaya et al[14] the mean length of right tibia were observed as 35.23 cm ± 2.401, the mean length of left tibia were 35.91 cm ± 2.110. In a study conducted by Erika Collipal[15] the mean length of right tibia were observed as 355.8 mm and the mean length of left tibia was 354.9 mm.

In the present study we observed double nutrient foramen in one left tibia (2%) and the remaining tibia (98%) showed single nutrient foramen which almost coincide with studies reported by Kirschner et al[5] (93.5% a foramen & 6.5% two foramina) & Longia[16] et al (95% a foramen and 5% two foramina).

In our present study, 80% of the tibia showed primary type of NF and 20% showed secondary nutrient foramen (73.06% left and 87.5% right). The study conducted by Udhaya et al [14] showed predominantly primary/dominant type of nutrient foramina 88.14% for 135 tibia,{ right (87.14%) and left side (89.23%) }.

In our study the location of NF was situated on the soleal line in 4/26 (15.38%) left tibia and 3/24 (12.5%) right tibia, was located medial to the soleal line in 4/26 (15.38%) left tibia and 4/24 (16.66%) right tibia and in the remaining tibia it was located lateral to the soleal line. According to Erika Collipal et al [15], 3.77% of bones showed NF over the soleal line. In our study the nutrient foramen was located on the interosseus border in one right tibia and was located on the vertical line in one right tibia. .In a study conducted by K. Udhaya et al, the NF in 99 (70.71%) were lying lateral to the vertical line, in 17 (12.14%) the NF were lying on the vertical line, 12 (8.57%) were medial to vertical line, 7 (5%) were on the interosseous border.

In our study the location of NF in 23 left tibia (88.46%) and 22 right tibia (91.66%) was in the upper third of the shaft and in three left tibia (11.53%) and two right tibia (8.33%) it was situated in the middle third of the shaft. In a study conducted by K. Udhaya et al [14] 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}. No foramina were found in the distal third of tibia.

In our present study in all the cases (100%), the direction of nutrient foramen was directed vertically downwards. In a study conducted by K. Udhaya et al [14] 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%).

In our present study the mean of maximum diameter of nutrient foramen on the left tibia was 0.6 mm and on the right tibia was 0.7 mm.

In our present study the mean of lateromedial diameter of the shaft at the level of nutrient foramen on the left tibia was 28 mm and on the right tibia was 26 mm. The mean of anteroposterior diameter of the shaft at the level of nutrient foramen on the left tibia was 34 mm and on the right tibia was 34.5 mm. In a study conducted by

Erika Collipal et al [15]. the mean of lateromedial diameter of the shaft at the level of nutrient foramen on the left tibia was 24 mm and on the right tibia was 24.1mm . The mean of anteroposterior diameter of the shaft at the level of nutrient foramen on the left tibia was 33.4mm and on the right tibia was 34mm.

In our study the mean of distance between the nutrient foramen and the highest point of intercondylar eminence on the left tibia was 130 mm and on the right tibia was 134 mm. In a study conducted by K. Udhaya et al[14] the mean distance of right tibia between the nutrient foramina and the apex of the intercondylar eminence was 10.79 cm ± 1.565, and the left tibia was found to be 11.30 cm ± 1.237.

In our present study the mean foramen index (FI) of the right tibia was 35.92 and of the left tibia was 34. In a study conducted by Erika Collipal et al[15] the mean foramen index on the right side were 30.60 ± 3.804 and on left side was 31.45 ± 2.906.

In transplant techniques, the use of data on the nutrient foramina distribution in long bones makes it possible for the professional to select the osseous section levels of the receptor in order to place the graft without damaging the nutrient arteries, preserving, thus, the diaphyseal vascularization and the transplant consolidation[17].

FIGURES

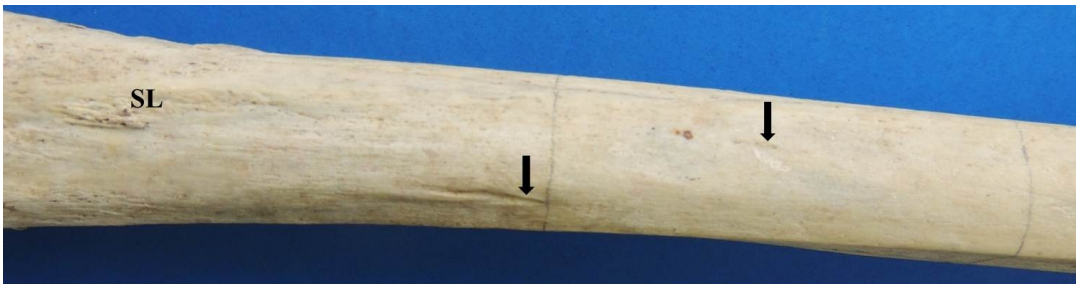

Figure 1. Tibia showing double nutrient foramina (arrows). SL – Soleal line

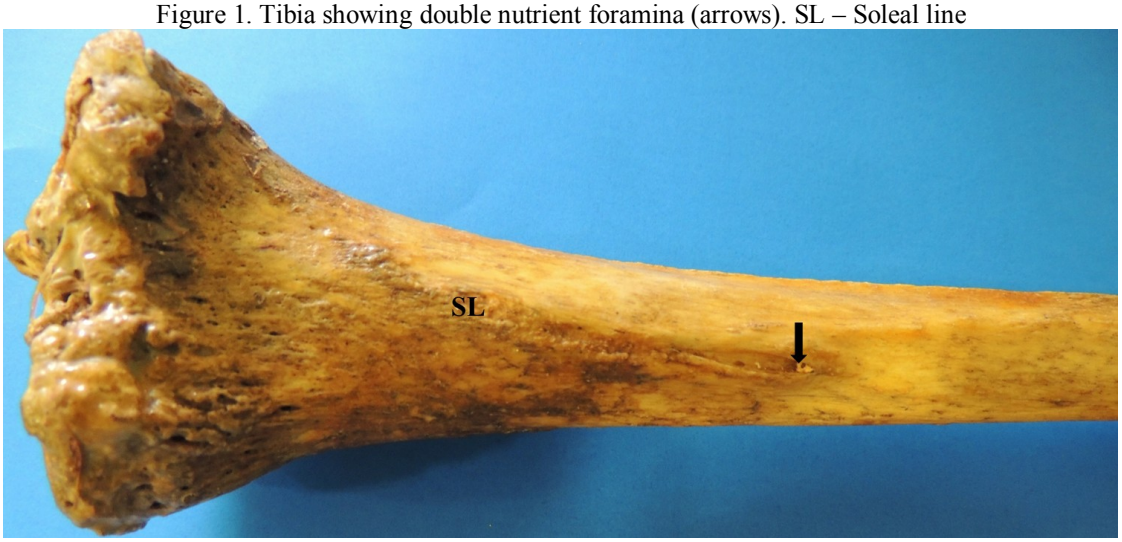

Figure 2. Right tibia showing nutrient foramen (arrow) on the soleal line (SL).

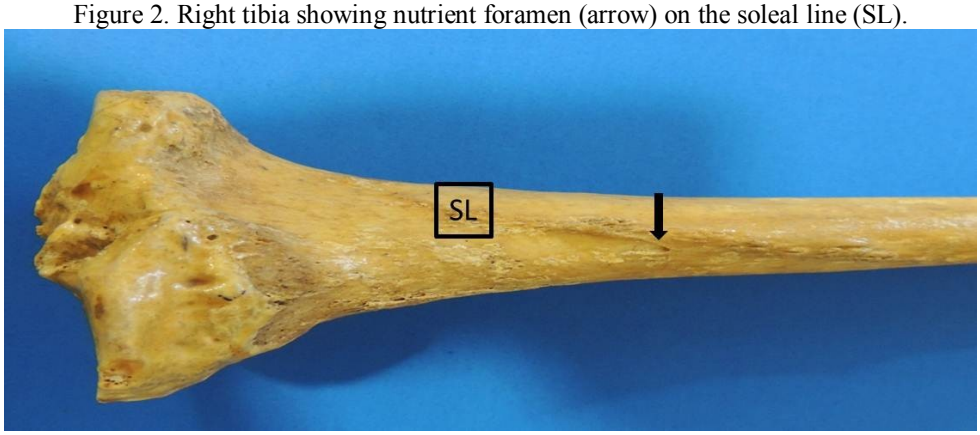

Figure 3. Right tibia showing nutrient foramen (arrow) medial to soleal line (SL)

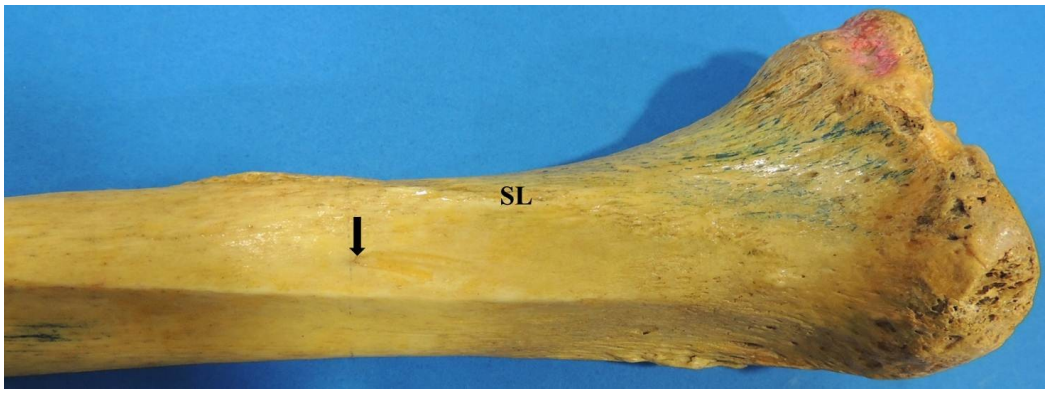

Figure 4. Right tibia showing nutrient foramen (arrow) lateral to soleal line (SL).

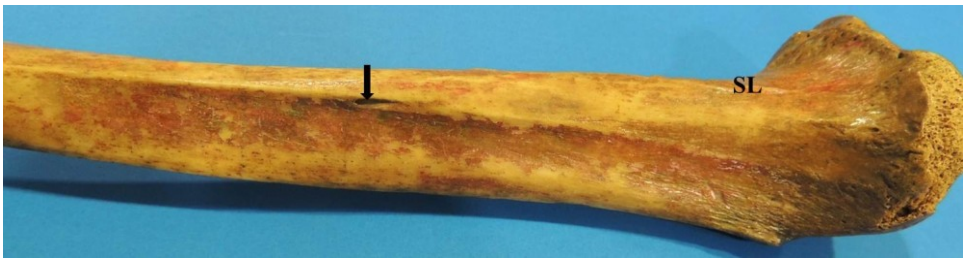

Figure 5. Right tibia showing nutrient foramen (arrow) on interosseous border. SL – Soleal line

Figure 6. Right tibia showing nutrient foramen (arrow) on the vertical ridge. SL – Soleal line

V. CONCLUSION

In bone grafts, the nutrient blood supply is crucial and it should be preserved in order to promote the fracture healing. Moreover, the presence of preserved nutrient blood flow is essential for the survival of osteocytes in cases of tumor resection, traumas. The present detailed study of nutrient foramen of tibia will enable the surgeons to proceed with a successful graft transfer and also to avoid damage to the nutrient vessels during surgical procedures.

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