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Anthropometric Analysis of Nutrient Foramen of Tibia - A Study in Eastern India

Tapas Ghosh[1], Mrinal Kanti Ray[2]

[1]Associate Professor, Anatomy Department, [2]Associate Professor, Orthopedics Department, Burdwan Medical College and Hospital, Burdwan, West Bengal, India

Corresponding Author: Mrinal Kanti Ray

ABSTRACT

The morphological knowledge of nutrient foramen is important, but there can be variations.
172 dry adult tibia of unknown age and sex were studied in the present observational, cross sectional study conducted in the departments of Anatomy and Orthopedics of a tertiary care medical college and hospital.
A single NF was observed in all tibia. 84 and 85 NF were directed downwards in the right and left tibia respectively. Location of nutrient foramen on the shaft was found as follows: for the right tibia, on the posterior, lateral and medial surfaces the numbers of cases were 85, 1 and 0 respectively; numbers for the same location for the left tibia were 83, 2 and 1 respectively. The NF was found to be located lateral to, medial to and on the soleal line in 84, 0 and 2 cases in right tibia, and 82, 1 and 3 cases in left tibia. Distance of NF from junction of upper 1/3 & middle 1/3 of shaft was found to be (in Mean $\pm$ SD) 17.8$\pm$3.1 and 17.6$\pm$2.9 for right and left tibia.
The present work should provide various disciplines of doctors, especially orthopedic surgeons with data that will help in various surgical procedures, especially to avoid damage to the nutrient vessels. Still, further research work with other parameters should be carried out.

Keywords: nutrient foramen, tibia, anatomy, orthopedics

INTRODUCTION

The nutrient foramens (NF) are cavities that conduct the nutrient arteries and the peripheral nerves. [(1)] The role of NF in nutrition and growth of the bones is evident from term "nutrient" itself. [(2)] The external opening of the nutrient canal, i.e. the NF, has a particular position for each bone. [(3)] NF, in the majority of cases, is located away from the growing end. [(4)] Henderson RG reported that their position in mammalian bones are variable and may alter during the growth. [(5)] It is generally agreed that the vessels which occupy the NF are derived from those that took part in the initial invasion of the ossifying cartilage, so that the NF was at the site of the original centre of ossification. [(3)] The morphological knowledge of NF is significantly important for orthopedic 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. [(6)] Again, position of the fracture relative to the NF of the long bone and the patterns of edema are the secondary signs in the key of the diagnosis of this type of fracture. [(7)] Broadly stating, an understanding of the position and number of the NF in long bones is important in orthopedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery. [(8)]

Keeping in mind the numerous variations that may occur, the aim of the present investigation was to study the topographic anatomy and morphology of the nutrient foramina in human tibia to help doctors of various disciplines including anatomy, orthopedics, surgery,

transplantation, etc in their work and to compare data from previous research.

MATERIALS AND METHODS

The present study was an observational, cross sectional study conducted in the departments of Anatomy and Orthopedics of a tertiary care medical college and hospital. 172 dry adult tibia of unknown age and sex were studied. Fully ossified and complete bones were included and bones with pathological changes or any kind of deformity or damage were excluded from the study. NF was identified by presence of a well marked groove and a raised margin at its beginning and its direction were determined by passing the needle into the foramen. The Sliding Vernier caliper (resolution = 0.05mm) was used for all the distance measurements. All the observations were made by two separate observers in order to avoid observer bias.

Following observations were made on each tibia: 1) Number of NF 2) Situation of NF in tibia (in reference to upper, middle or lower one-third of the shaft) 3) Direction of the NF (upward/downward) 4) Location of NF in reference to Soleal line on posterior surface of tibial shaft (Medial/Lateral to Soleal line) (5)Surface of the shaft where the NF is located (6) Distance of NF from Junction of Upper 1/3 & Middle 1/3 of shaft .

Observations were tabulated in Microsoft Excel worksheet. The mean and standard deviation were calculated. All the observations were analyzed by using SPSS software.

RESULTS

Table 1. Number and direction of NF

NF		Right tibia	Left tibia	Total
Number	Single	86	86	172
	Double	0	0	0
Direction	Downward	84	85	169
	Upward	2	1	3

Table 2. Location of NF on the shaft

	Right tibia	Left tibia	Total
Posterior surface	85	83	168
Lateral surface	1	2	3
Medial surface	0	1	1
Upper thirds	81	80	161
Middle thirds	1	1	2
Junction of upper and middle thirds	4	5	9

Table 3. Relation of NF with soleal line

	Medial to soleal line	Lateral to soleal line	On soleal line
Right tibia	0	84	2
Left tibia	1	82	3
Total	1	166	5

Table 4. Distance of NF from junction of upper 1/3 & middle 1/3 of shaft (in Mean ± SD)

Right tibia	17.8±3.1
Left tibia	17.6±2.9

DISCUSSION

In the present study, a single NF was observed in all tibia (table 1). This is almost in accordance with other researchers who had similar findings, for example, Kirschner et al found single foramina in 93.5% cases & two foramina in 6.5% cases; & Longia et al who determined 95% cases with one foramen and 5% cases with two foramina. [9, 10] The present study found 84 and 85 NF directed downwards in the right and left tibia respectively (table 1). Mazengenya P and Faremore MD reported direction of foramen upwards in 0.6% of tibia in black South Africans and in 1.7% of tibia in white South Africans. [11] In general, NF are directed towards elbow in upper limb (directed towards lower end of humerus and upper ends of radius and ulna), while in lower limb NF 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. [2]

Location of nutrient foramen on the shaft was found as follows: for the right tibia, on the posterior, lateral and medial surfaces the number of cases were 85, 1 and 0 respectively; numbers for the same location for the left tibia were 83, 2 and 1 respectively (table 2). Most authors also have reported the location of foramen on posterior surface. [12, 13] For the right tibia, the present study found 81, 1 and 4 cases had NF at the upper thirds, middle thirds of tibia and at the junction of upper and middle thirds respectively; for the left tibia the corresponding figures were 80, 1 and 5 respectively (table 2). Seema et al found 99.5 % cases and 0.5 % cases had NF at the upper and middle thirds of the shaft. [14]

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 as per Ankolekar et al. [(15)] In the present study, the NF was found to be located lateral to, medial to and on the soleal line in 84, 0 and 2 cases in right tibia, and 82, 1 and 3 cases in left tibia (table 3).

Distance of NF from junction of upper 1/3 & middle 1/3 of shaft was found to be (in Mean ± SD) 17.8±3.1 and 17.6±2.9 for right and left tibia. The authors could not find supporting literature for this data.

Some limitations of this study must be considered. For example, age and gender differences were not considered as the authors were not able to assess the age and sex of the bones. These might alter the data as the anatomy of foramina might be different in males and females. Some foramina might become ossified with advancing age. As the NF of the tibia may change during growth, the sample long bones should be confined to a specific age group. In the authors' opinion, forensic help might be taken to solve these problems. Further, the sample size was not large. So, extrapolation of the results to the general population should be done with caution.

The authors hope that the present study will be of help in future implication of these data, not only with their morphology and morphometry but also to compare them for further analysis. This study should provide more knowledge about clinical importance of nutrient foramina of tibia for orthopedic surgeons in various operations and especially to avoid damage to the nutrient vessels during surgical procedures.

CONCLUSION

The present work should provide various disciplines of doctors, especially orthopedic surgeons with data that will help in various surgical procedures, especially to avoid damage to the nutrient vessels. Moreover, information from this should aid further research work, though more supplementary studies with other parameters are required.

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