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A study of variations in nutrient foramen of dry human tibia with its clinical implication

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ABSTRACT: The blood supply to the long bones is by nutrient artery. Anatomically the nutrient artery that supply to the tibia is a branch of posterior tibial artery mostly and in few cases, it can be a branch of peroneal artery. Understanding the morphology and variations of the nutrient foramen is a major area of concern in the medical field especially in bone transplantation and forensic medicine. The present study aimed to study the variations in number, direction, position of nutrient foramen of tibia. 194 completely ossified dry tibia without any pathological conditions like fracture, bone tumor growth are taken from all the constituent colleges of Krishna institute of Medical sciences, Deemed to be university Karad. . Out of 194, 100 are of right side and 94 were of left side . Nutrient foramen in 65 bones (right) were ≥1.27 mm of size. 58 bones of (left) were ≥1.27 mm of size. Mean Length of tibia for right is 36.4 cm and for left is 37 cm. Distance from upper end to NF (Nutrient foramina) for right is 13.6 cm and left is 13.8 cm. Foramen in upper 1/3rd of tibia is observed in 80 of right side 76 in left side. Foramen in middle 1/3rd of tibia is in 20 Tibia of right 18 in left. The study results help in the surgical procedures as well as dealing with the medico legal cases. The study results add the literature about the variations in nutrient foramen of dry human tibia with its clinical implications. This data helps the surgeons to understand the variations which help them in better outcomes of their surgical procedures.

KEY WORDS: Bones, Diaphysis, Tibia, Nutrient foramen, Forensic medicine

I. INTRODUCTION

The blood supply to the long bones constitutes the nutrient artery. Anatomically the nutrient artery that supply to the tibia is a branch of posterior tibial artery mostly and in few cases it can be a branch of peroneal artery. The nutrient artery is the most important artery that supply to the cortical bone.[1] Especially, during the development of fetus and beginning of the process of bone ossification, the role of nutrient artery is immense as it is the only source of blood supply to long bone.[2] The nutrient artery enters the long bone through a foramen called nutrient foramen. The nutrient artery enters into the upper one thirds of the shaft of long bones. This has an importance in clinical anatomy. As the artery predominantly enters through upper one thirds of the shaft, the lower portions of the shaft will gets less nutrition especially in case of bone fractures.[2] As it is clear that the knowledge in Anatomy is the basis for any surgery, it is much needed for a clinician to update the all possible locations and variations of the nutrient artery in the long bones, which enables increase in the success rate of the surgical procedures that involves long bones especially in bone fractures.[3-6] Further knowledge about the number, location of the nutrient artery will helps the clinician in the graft process.[7] It also helps in dealing the medico legal cases. Hence, understanding the morphology and variations of the nutrient foramen is a major area of concern in the medical field. The present study aimed to study the number, direction, position, variations in nutrient foramen of tibia.

II. MATERIAL AND METHODS

Study setting: The study was conducted at all the constituent colleges of Krishna institute of Medical sciences, deemed to be university Karad.

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III. MATERIALS

194 completely ossified dry tibia without any pathological conditions like fracture, bone tumor growth taken all the constituent colleges of Krishna institute of Medical sciences, Deemed to be university Karad. The bones which were selected for the study were ossified and the bones which were not complete and bones with any pathological changes were excluded from the study. The observations performed in the selected bones were size, length, number, direction, position, variations in nutrient foramen of tibia.

IV. METHODS

All the observations were made by two separate observers in order to avoid observer bias.

Size of the foramen: Hypodermic needle was used to measure the size of the foramen.[8] Based on the size of the foramen was divided into dominant and secondary foramen. As per the standards mentioned in the literature, if the size is less than needle 24 size, it was considered as secondary nutrient foramen whereas if the size is higher, it was marked as dominant foramen.[9]

Number of foramen: The number of the foramen was observed and grouped the bones into single and multiple nutrient foramen bones. If there is only one foramen, it was considered as single nutrient foramen bone. If there is multiple foramen, it is considered as multiple nutrient foramen bone. Observation was also performed to identify the bones without the nutrient foramen.

Size of foramen: The size of the foramen was measured using syringe needle of various gauges.[9]

Location of the foramen: Location of nutrient foramen in reference to Soleal line was assessed using the standard foraminal index as mentioned in the literature**.**[10]

Other observations: The direction, variations were observed as per the standard protocol mentioned in the literature.[10] In all Tibia the direction of nutrient foramen was vertically downward.

Ethical considerations: The present study was approved by the institution ethics committee.

V. RESULTS

Total number of bones is 194. Out of which 100 right and 94 were left. Size of the foramen (right) (N=100) is presented in table no 1. 65 bones (right) were ≥1.27 mm of size (table no 1). Size of the foramen (left) (N=94) is presented in table no 2. 58 bones (left) were ≥1.27 mm of size (table no 2). Length of Tibia and distance from upper end to Nutrient foramina is presented in table no 3. Mean Length of tibia for right is 36.4 cm and for left is 37 cm. Distance from upper end to NF (Nutrient foramina) for right - 13.6 cm and left - 13.8 cm. One foramina is present on anterior border of Tibia. (Fig. 1) Tibia with double nutrient foramina is observed in 8 Tibia. (Fig. 2) In 2 Tibia nutrient foramina is absent. (Fig. 3) Foramen in upper 1/3rd of tibia is observed in 80 of right side 76 in left side. Foramen in middle 1/3rd of tibia is in 20 Tibia of right 18 in left.

Calculation of the foramen index

FI = (DNF/TL)*100

DNF = the distance from the proximal end of the bone to the nutrient foramen.

TL = total bone length.

Foramen in upper 1/3rd of tibia – 80 in right 76 in left

Foramen in middle 1/3rd of tibia – 20 in right 18 in left

Table no 1: Size of the foramen (right) (N=100)

S.No	Size of the foramen (right) (N=100)	Number
1	≥1.27 mm	65
2	≥ 0.90mm to < 1.27mm	23
3	≥ 0.71mm to < 0.90 mm	7

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4	≥ 0.55mm to < 0.71 m	5

Table no 2: Size of the foramen (left) (N=94)

S.No	Size of the foramen (left) (N=94)	Number
1	≥1.27 mm	58
2	≥ 0.90mm to < 1.27mm	17
3	≥ 0.71mm to < 0.90 mm	8
4	≥ 0.55mm to < 0.71 m	11

Table no 3: Length of Tibia and distance from upper end to Nutrient foramina

	Right	Left	Foramen index (FI)
Length of Tibia	36.4 cm	37 cm	37.36
Distance from upper end to Nutrient foramina	13.6 cm	13.8 cm	37.29

Fig 1. Foramina is present on anterior border of Tibia.

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Fig. 2 Double foramen. jpg

Fig. 3 absent foramen.jpg

VI. DISCUSSION

Majority of the nutrition to the long bone is contributed by the nutrient artery. This nutrient artery which supply to the long bones was derived from the posterior tibial artery. Total number of bones is 194. Out of which 100 right and 94 were left. 65 bones (right) were ≥1.27 mm of size. 58 bones (left) were ≥1.27 mm of size (table no 2). Length of tibia for right median is 36.4 cm and for left is 37 cm. Distance from upper end to NF (Nutrient foramina) for right - 13.6 cm and left - 13.8 cm. Earlier studies reported presence of one or two foramen and other study by Mazengenya etal reported bone with six foramen. Regarding the location of the foramen, majority of the studies reported that the foramen is present in the middle third of shaft. [11-13] The present study agrees with earlier studies. It was reported that in appearance of the nutrient foramen linearly the radiographs may mimic the fractures of bones. Also one must be cautions while examining the anterior nutrient foramen as it can mislead osseous pathology.[14] This knowledge is essential while surgical handling of the long bones which has undergone surgeries. During the development, all the nutrient arteries course caudally and further Course depends on the development of the ends of the long bones. [15] However, other studies reported that this concept may not be true always in humans.[16-17] Interestingly; another study reported that the nutrient foramen is present away from the knee joint.[18-20]

Clinical implications: While performing the surgeries in the management of bone fractures, it is very much essential to preserve the blood supply of the bones. The same is also applied during the replacement of joints and grafting of bones. Preserving the blood supply is very important as it also promotes the healing process. Hence, the present study adds the literature about the knowledge of the nutrient foramen.

Forensic implications: When it comes to forensic implications, there may be conditions where a forensic doctor has to differentiate the bone of human with non-human, where there may be availability of small fragment of long bone is present. Macroscopic and computed tomography (CT) analysis of nutrient foramina plays a vital role in this cases. [21-23]

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VII. CONCLUSION

The study results add the literature about the variations in nutrient foramen of dry human tibia with its clinical implications. This data helps the surgeons to understand the variations which help them in better outcomes of their surgical procedures.

Conflicts of interest: None declared

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