Original Research Article

Study of nutrient foramen in dry human tibial bone

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Abstract

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. 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. **Materials and Methods:** This was a descriptive study conducted in the Department of Anatomy, M.G.M. Medical College, Jamshedpur from January 2020 to December 2020. Sample selection was done according to the study of Chavda H.S and Jethva N K. For this study 80 dry adult tibiae available in the department were used. The age and sex were unknown. Fully ossified and complete bones were included in the study. Bones with pathological changes or any kind of deformity were excluded from the study. The right and left limb bones were measured. The total length of each tibia from the uppermost point on the superior surface of tibia to the lower end was measured using an vernier caliper. **Results:** In the present study 75 (93%) of tibiae showed presence of PNF. It was directed downwards and was located on the posterior surface of tibia. 39 of the 43 right tibiae had single PNF, 1 right tibia had 2 NF: one primary and one secondary, the secondary NF was directed upwards. 36 of the 37 left tibiae had single PNF, in one left tibia 2 NF was observed: one primary and one secondary, the secondary NF was directed upwards. NF was not observed in two bones on right side (2 %) and one bone on the left side (1 %). Number of NF, number and percentage of bones are tabulated in Table 2. 84 % of the PNF was located on the posterior surface of the middle segment. 13.3 % of the PNF was located on the posterior surface of the upper segment of the tibia (Table 3). All the PNF were directed downwards whereas SNF were directed upwards, and they were located in the lower segment. **Conclusion:** It is very important for surgeons to have sound knowledge of precise topography of nutrient foramen which will help in preserving vasculature of the bone during various surgical procedures like fracture fixation, bone grafting, knee replacement surgeries and tumour resection. Understanding of exact location and distribution of nutrient foramen will help in avoiding damage to nutrient vessels during surgery. This will ensure less post-operative complications, as well as this helps in better outcome of operative procedure.

Key Words: nutrient artery, SNF, PNF, fracture fixation.

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.

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Materials and methods

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Sample selection was done according to the study of Chavda H.S and Jethva N K. For this study 80 dry adult tibiae available in the department were used. The age and sex were unknown. Fully ossified and complete bones were included in the study.

Bones with pathological changes or any kind of deformity were excluded from the study. The right and left limb bones were measured. The total length of each tibia from the uppermost point on the superior surface of tibia to the lower end was measured using an vernier caliper. The total length was divided into three segments, upper, middle and lower by marking a distance of 10, 20 and 30 cm from the upper end of the bone. Primary nutrient foramina were identified by the presence of well-defined groove leading to it. Foramina that allowed the passage of a 24-gauge needle were considered as PNF and those with lesser diameter as secondary nutrient foramina (SNF). The number, direction and position on the surface of bone of the PNF were noted. The distance of the PNF from the upper end of tibia was also measured using vernier caliper.

Statistical Analysis

Parameters of the right and left sides were compared. Observations were tabulated in Microsoft Excel worksheet and average and

standard deviation of total tibial length, average and standard deviation of the distance of nutrient foramina from proximal end of tibia were calculated. Percentage of PNF was calculated and the direction of PNF on the shaft of tibia was observed. R software (R version-3.3 Aril 2016) was utilised for data analysis.

Results

The mean total length of tibia on the right side was 35.57 ± 2.48 cm and on the left side was 35.5 ± 2.55 cm. The mean distance of the PNF from the upper end of tibia on the right side was 11.73 ± 1.72 cm and on the left side was 11.73 ± 1.43cm (Table 1).

In the present study 75 (93%) of tibiae showed presence of PNF. It was directed downwards and was located on the posterior surface of tibia. 39 of the 43 right tibiae had single PNF, 1 right tibia had 2 NF: one primary and one secondary, the secondary NF was directed upwards. 36 of the 37 left tibiae had single PNF, in one left tibia 2 NF was observed: one primary and one secondary, the secondary NF was directed upwards. NF was not observed in two bones on right side (2 %) and one bone on the left side (1 %). Number of NF, number and percentage of bones are tabulated in Table 2.84 % of the PNF was located on the posterior surface of the middle segment. 13.3 % of the PNF was located on the posterior surface of the upper segment of the tibia (Table 3). All the PNF were directed downwards whereas SNF were directed upwards, and they were located in the lower segment.

Table 1: Measurement of total length of Tibia and distance of Primary Nutrient Foramina from upper end of tibia

S.No	Total number of Tibia =80	Total length of bone TL(cm), Mean with SD	Distance of PNF from upper end of bone, D (cm) Mean with SD
1	Right=42	35.56±2.48	11.73±1.72
2	Left=38	35.50±2.55	11.73±1.43

Table 2: Incidence of Nutrient Foramina in shaft of tibia

S.No	Total number of Tibia =80	Right			Left		
1	No of foramina	0	0	0	0	1	1
2	No of bones	1	40	1	1	34	1
3	Percentage of bones	2.38	95.23	2.38	2.63	92	5.260

Table 3: Segmental position of nutrient foramina in shaft of tibia (NF-Nutrient Foramina, PNF -Primary Nutrient Foramina, SNF - Secondary Nutrient Foramina)

S.No	Position of NF	Total number of NF	Percentage of NF
1	S1-upper segment 1/3rd (up to 10 cm length from upper end of tibia)	11 (PNF)	13.75
2	S2-middle segment 1/ 3rd (up to 20 cm length from upper and of tibia)	67 (PNF)	83.75
3	S3-Lower segment 1/3rd (Up to 30 cm length from upper end of tibia)	3(SNF)	3.75
4	Zero NF	2	2.5

Discussion

Blood supply to the long bones is mainly derived from nutrient artery which is essential for bone growth. If the nutrient artery is damaged while operating on tibia, it may result in ischemia which will lead to interference with the healing process. Therefore, anatomical knowledge of nutrient artery is crucial prior to surgery[7]. In the present study a PNF was observed in 97.5 % of tibia. Many authors also found single PNF in most of the bones. In most of the tibia nutrient foramen was directed downward in the present study. This finding was in accordance with studies conducted by most of the authors, In the present study upward directed SNF was noted in 4 bones, PNF was observed on the posterior surface of shaft. SNF was located on the lateral surface of the lower segment. Most of the authors have also reported the location of PNF on the posterior surface in most of the bones[8].Kamath V et al. observed PNF on medial surface in 2.82 % of bones[6].Regarding location of nutrient foramen on posterior surface of shaft, it was observed by most of the authors that it was located below the soleal line. This finding was similar to the present study. Average distance of nutrient foramen from proximal end was found to be 11.73 ± 1.72 on right and 11.7 ± 1.43 on left which is similar to the study of Chavda H.S. and Jethva N.K[9].Mohan K et al. found PNF on upper 1 / 3rd in 42 % of bones, while in 52 % it was on middle 1 / 3.rd. No PNF was found in the lower 1 / 3rd of tibia[10]. It is similar to our study, in lower 1 / 3rd SNF only observed. Vadhel C.R. et al. in their study on Gujarati population found occurrence of nutrient foramen on upper 1 / 3 in 99.5 % of bones which was higher percentage than the present study findings[10].

A single diaphyseal nutrient foramen, which was directed away from the growing ends (upper ends) was noted by Kamath V et al. in their study on tibia and fibula. Kamath V et al. concluded that the nutrient foramina of femur, tibia and fibula were located on the posterior (the flexor aspect) of the bones mainly. Knowledge of position of NF has a probable role in few cases of vascular necrosis. It is reported that the position of NF was directly related to the requirements of a continuous blood supply to specific aspects of each bone, for example, where there were major muscle attachments In leg the posterior compartment is the flexor compartment which has bulkier, stronger and more active muscles than the extensor compartment. Therefore, posterior compartment needs more blood supply than anterior compartment. In present study 96.6 % of NF were present on posterior surface which is similar to previous studies.

Conclusion

It is absolutely essential for the surgeon to have a sound knowledge of the location and number of these foramina, so as to prevent any inadvertent injuries during surgery. The present study of these parameters will provide useful data and aid those undertaking surgical interventions of tibia. It is very important for surgeons to have sound

knowledge of precise topography of nutrient foramen which will help in preserving vasculature of the bone during various surgical procedures like fracture fixation, bone grafting, knee replacement surgeries and tumour resection. Understanding of exact location and distribution of nutrient foramen will help in avoiding damage to nutrient vessels during surgery. This will ensure less post-operative complications, as well as this helps in better outcome of operative procedure.

References

1. Udaya kumar P,Jnardhan Rao M, Sirisha V, Kalpana T. A study of nutrient foramina in dry human Tibia bones of Telangana region. Int J Anat Res . 2017;5(3.1):4152-57.
2. Udhaya K., Devi K.V., Sridhar J., Analysis Of Nutrient Foramen Of Tibia-South Indian Population Study Int J Cur Res Rev. 2013;05(08):91-98.
3. Kumar R, Mandloi R.S., Singh A. K. Kumar D etal. Analytical And Morphometric Study Of Nutrient Foramina Of Femur In Rohilkhand Region. Innovative Journal of Medical and Health Science 2013;3:52-54.
4. Kizilkanat E, Boyan N, Ozsahin ET, Soames R, Oguz O,Location, number and clinical significance of nutrient foramina in human long bones, Ann Anat.2007;189(1):87-95.
5. Craig, J.G., Widman, D., van Holsbeeck, M., Longitudinal stress fracture: patterns of edema and the importance of the nutrient foramen. Skeletal Radiol. 2003; 32:22-27.
6. Dickson K, Katzman S, Delgado E, Contreras D. Delayed unions and nonunions of open tibial fractures. Correlation with arteriography results. Clin Orthop Relat Res. 1994;(302):189-93.
7. Forriol F, Gomez L, Gianonatti M, Fernandez R A study of the nutrient foramina in human long bones. Surg Radiol Anat 1987;9: 251–255.
8. McKee NH, Haw P, Vettese T. Anatomic study of the nutrient foramen in the shaft of the fibula. Clin Orthop 1984;184: 141–144.
9. Trueta J. Blood supply and the rate of healing of fractures of the tibia. Clin Orthop 1974; 105: 11–26.
10. Osterman AL, Bora FW. Free vascularized bone grafting for large-gap non-union of long bones. Orthop Clin North Am 1964; 15: 157–163.

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