

Morphological and Morphometric Study of Nutrient Foramen of Tibia and its Clinical Implication in the South Rajasthan Region

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ABSTRACT

Background: Human body is made up of framework of variety of bones and make human body Bone is core structure of the human skeleton and form the framework of the human. During embryological and fetal life arteries enter into long bone through nutrient foramen and entry into medullary cavity, which is, require for growth long bone. Various surgical procedures like fracture reduction, bone grafting and joint replacement require sufficient knowledge of nutrient foramen and nutrient artery.

Aim: The Aim of the present study is: (A) To identify the position, number & direction of diaphyseal nutrient foramina of Tibia. (B) To identify any variations in number, location and position of diaphyseal nutrient foramina of tibia. (c) calculate the foramina index by Hughes formula.

Materials and methods: Present study was conducted on 100-dried Human Tibia with unknown age and sex, which was taken from the anatomy department of Geetanjali medical college & Hospital Udaipur and Pacific medical college & hospital, Udaipur and marked number on it. Morphological and pathological abnormal bones excluded from study. Help of vernier caliper and fine gauge needle, we observed location and distance from proximal end, number and direction of nutrient foramen and calculate foramina index.

Results: In present study we found single foramen present in 80 bone, Double foramen present 18 bone and in 2 bone there was triple foramen at different level. According direction: In upward direction of foramen found in 1 bone, horizontal direction found in 3 bone and most of bone have downward direction. According location: In most of bone Nutrient foramen was situated on posterior surface except in four bones where it was situated on lateral surface and In 66 bone Nutrient foramen present in upper 1/3 of bone except 34 bone where it present in middle 1/3.

Conclusion: In present study we found, Nutrient foramen was located mostly on the posterior surface and direction was downward. Nutrient artery is very important for blood supply of long bones. Therefore, it is very important for surgeons to have sound knowledge of precise morphology and morphometric of nutrient foramen

Keywords: Nutrient foramen, Nutrient artery

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INTRODUCTION

Long bone of human body gets nutrition mainly from 3 artery 1) Nutrient artery, 2) Periosteal artery, 3) Epiphyseal Artery. But main source of blood derived from Nutrient artery, which supply diaphysis and metaphysis. During its course Nutrient artery first enters into the bone through nutrient foramen.¹ According to various cadaveric studies the Nutrient foramen is directed away from the growing end of in Adult the bone.^{2,3} In lower limb leg bone, nutrient foramen is generally directed downwards because upper end is growing end, as it fuses with shaft in the 16 and 18 year in female and males

respectively. While lower-end fuses with the shaft at about 15th year in females and 17th year in males. For tibia Nutrient artery derived from a branch of posterior tibial artery. Rarely it may arise from popliteal artery or anterior tibial artery.³ Nutrient Artery is very important and vital for early embryogenic development and maturity of bone.³ Nutrient artery provides 70-80% of blood supply to the long bones of human and if any deterioration in blood supply of long bone during early child and adult life, it may affect the growth of long bone if injury during fracture reduction, bone grafting

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and joint replacement lead to ischaemia of long bone resulting into less vascularisation of diaphysis, metaphysis and growth plate.⁴ Because of this orthopedic and surgeons to have well knowledge of nutrient foramina before go to surgery to prevent catastrophic damage artery. The tibia is commonly involved in several surgical procedures like bone grafting, the knee replacement, external and internal fixation of fractures and bone resection for tumours.^{5,6} Present study was conducted for knowledge of morphology and morphometric of nutrient foramen on tibia.



Fig 1: Showing distance from proximal end of Tibia to Nutrient Foramen

METHODS

The present study included 100 dried tibia bones with unknown age and sex, which was taken from the anatomy department of Geetanjali medical college & Hospital Udaipur and Pacific medical college & hospital, Udaipur and marked number on it. Morphological and pathological abnormal bones excluded from study.

Help of vernier caliper and fine gauge needle, we study 53 right sided tibia and 47 left sided tibia. We study A) Number of foramen present on bone. B) Location of foramen present on which surface. C) Nutrient foramen direction. D) Total Length (TL) of Tibia. E) Distance (PF) from proximal end of tibia. F) With Help of Hughes formula, we calculated Foramina Index.

Number, Location and Direction observed macroscopically with help of gauge needle and osteometric board was noted. Total length (From the Upper margin of the medial condyle and lower end of medial malleolus and Distance of Foramina measured from proximal end of Tibia.

Foramina Index: with help of Hughes formula, we calculated our data.

$$\text{Foraminal index} = \text{PF/TL} \times 100$$

According to index,

Position of foramen was determined Accordingly,

- A) Foramen is in the Lower 1/3 of the bone if Index >66.66
- B) Foramen is in the Middle 1/3 of the bone if Index between 33.33 to 66.66
- C) Foramen is in the Upper 1/3 of the bone if Index < 33.33

RESULTS

In present study we found single foramen present in 80 bones, Double foramen present 18 bones and in 2 bones there was triple foramen at different level. According direction: In upward direction of foramen found in 1 bone, horizontal direction found in 3 bone and most of bone have downward direction. According location: In most of bone Nutrient foramen was situated on posterior surface except in four bones where it was situated on lateral surface and in 66 bone Nutrient foramen present in upper 1/3 of bone except 34 bone where it presents in middle 1/3.

Table 1: Showing average Total length, distance from proximal end and number of nutrient foramen of Tibia.

	Total length Tibia (TL) (Average in cm)	Distance from Nutrient foramen from Proximal end of Tibia (PF) (Average in cm)	Number of foramen present on bone		
			Upper 1/3	Middle 1/3	Lower 1/3
Rt	36.5	12.1	35	18	0
LT	36.8	11.92	31	16	0

Table 2 Showing direction and location of Nutrient foramen

	Number foramen			Direction of Foramen			Location of foramen (surface)	
	Single	Double	Triple	Downward	Upward	Horizontal	Posterior	Lateral
Rt	42	9	2	52	1	3	56	4
Lt	38	9	0	44	0	0	40	0

DISCUSSION

Long bone in human is mainly supply by Nutrient artery which enter into bone through nutrient foramen then it divided into ascending and descending branch then supply rest part of

bone and provide nutrients to bone which require for growth of bone. The entry point is present in diaphysis that why this artery also called diaphyseal artery. For any fracture surgery and reconstructive surgery there have very caution about this artery and its course. Any injury to nutrient artery during surgery which cause the catastrophic event which very dangerous to bone growth in child. Because of this depth knowledge of anatomy of this artery is very important for orthopedic and surgeon.

In our study, we studied many parameters.

Number of foramen: In present study we found single foramen in 80 bone and most authors study found same, our study noticed Double nutrient foramina were found in 18 numbers of bones. Zahra SU et al. found around 4.5 % bone have double foramen,⁷ Seema et al. reported 10% bone have dual foramen,⁸ other author like Roul B et al. and Udaya P et al., noted 16.2% and 23.8 % of double foramina in bone which higher than other study.^{9,10} We have found triple foramen in our study was only 2 % it also less number in other study like Swapna SA and Udaya P found 3.80% and 2.70% in their studies.¹⁰ In our study we have not found any bone without nutrient foramen but few study found absent nutrient foramen like Joshi P, Prashanth KU and Gupta RK observed there is no nutrient foramen in 6%, 1.4% and 6.20% of tibia respectively.¹¹⁻¹³ In this case blood supply carried by periosteal vessel.¹³

Direction of foramen: There are changing in direction of nutrient foramen during embryological and after birth. Starting period of life nutrient arteries going in caudal direction toward growing end but in long bone growth is different because of this nutrient artery is directed away from the growing end.⁴ In our study mostly all bone has nutrient foramen direction was downward, only less 1 and 3 % bone have upward and horizontal direction. Also, Mazengenya P and Faremore MD, noted direction of foramen upwards in 0.6% and 1.7% of tibia in South Africans population.¹⁴

Location of Foramen: In our study, most bone's nutrient foramen was found on posterior surface the tibia 96 % except in 4% bones where it was found on the lateral surface, many textbooks and studies of various of authors also have noted the location of foramen on posterior surface in most of the bones but some author found on medial surface like Kamath V et al., found foramen on medial surface in 2.82% of bones.⁶ Hiren Chavda found in 87.14% of bones, foramina were located lateral to vertical line; in two bones it was medial to vertical line and in four bones on the vertical line.¹ Seema et al., and Collipal E et al., found 3.77% and 4% of tibia having nutrient foramen on the soleal line.^{8,15}

Total Length of tibia (TL): In our study we found total length of tibia was 36.5 and 36.8 on rt and Lt side. Hiren Chavda was found to be 35.1±2.3 cm on right side and 35.2±1.96 cm on the left side.¹ In black South Africans and white South African length were 38.44 cm and 37.12 cm observed by Mazengenya P and Faremore MD.¹⁴ In Turkish population length of tibia was 35.8 cm noted by Kizilkanat E and Pereira GAM et al., found it to be 37.31 cm .^{16,17}

Average distance of nutrient foramen from proximal end (PF); In present study we found there was distance between

proximal end and foramen was 12.1 and 11.92 on Rt and Lt side respectively. According to Hiren Chavda observation, the distance was 11.8±1.93 cm on right side and 11.8±2.28 cm on left side.¹ Ankolekar VH et al., found distance was 13 cm and 13.4 cm on the right and left side respectively.² Joshi P and Mathur S, found on Rajasthani population, this distance was 14.53±3.77 cm on right side and 14.0±2.99 cm on left side.¹¹

Distance of nutrient foramen from proximal end (PF): Average distance of nutrient foramen from proximal end in our study was 12.1 cm and 11.92 cm respectively on Right and left side. Hiren Chavda et al., observed in their study was 11.79 cm and 11.8 cm on the right and left side respectively.¹ Joshi P and Mathur S, found distance was as 14.53±3.77 cm on right side while 14.0±2.99 cm on left side.¹¹

Foraminal Index (FI): In our study was found to be it was in the middle 1/3. Gupta RK and Gupta AK also observed similar findings in Gujarati population.¹³ Vadhel CR 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 than the present findings.¹⁸ Mohan K et al., found it on upper 1/3 in 42% of bones while in 52%, it was on middle 1/3.¹⁹ No foramen was found in the lower 1/3rd of the tibia. Kamath V et al., reported nutrient foramen in upper 1/3rd in 74.65% of bones and in middle 1/3rd in 25.35% of bones.⁶ Pereira GAM et al., and Mazengenya P and Faremore MD, in their studies also found nutrient foramen more commonly on upper 1/3rd more than on the middle 1/3rd.^{14,17}

Table 3: Showing comparison of various study about Number of Nutrient foramen

Author (Year of study)	Number of Bone include in study	Nutrient foramen number (%)							
		1		2		3		Absent	
		Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt
Hiren S. Chavda et al. (2018)	70 (Rt-35, Lt-35)	100	100	-	-	-	-	-	-
Zahra SU et al. (2018)	91 (Rt-40, Lt-51)	97.5	96.0	2.5	1.96	-	-	-	1.96
Joshi P et al. (2018)	50 (Rt-21, Lt-29)	94	-	-	-	-	-	-	6
Udaya P et al. (2017)	151 (Rt-74, Lt-77)	83.70	89.6	13.5	10.3	2.70	-	-	-
Vinay G et al. (2017)	90 (Rt-45, Lt-45)	96.66	-	3.33	-	-	-	-	-
Mohan K et al. (2017)	150	98	-	2	-	-	-	-	-
Swapna SA et al. (2016)	-	94.30	-	1.90	-	3.80	-	-	-
Agarwal SA et al. (2016)	80 (Rt-40, Lt-40)	100	-	-	-	-	-	-	-
Seema et al. (2015)	60 (Rt-30, Lt-30)	93.34	96.6	6.60	3.30	-	-	-	-
Mazengenya P et al. (2015)	180 (Rt-90, Lt-90)	98.30	-	1.70	-	-	-	-	-
Roul B et al. (2015)	37	83.70	-	16.20	-	-	-	-	-
Gupta RK et al. (2014)	312 (Rt-161, Lt-151)	97.51	94.7	0.62	-	-	-	1.86	4.34
Ankolekar VH et al. (2013)	50	98	-	0	2	-	-	-	-
Present study (2019-20)	100 (Rt-53, Lt-47)	42	38	9	9	2	-	-	-

Table 4: showing comparison of various study in different parameter of location, length of bone and foramina index.

Author	Location Foramen % bone				Mean length of bone [cm]		Foraminal Index[cm]	
	Upper 1/3		Middle 1/3		Rt	Lt	Rt	Lt
	Rt	Lt	Rt	Lt				
Hiren S. Chavda et al	62.8 5	65.71	33.1 4	34.2 8	35.1±2.3	35.2±1.96	33.8±5.43	33.5 ± 5.56
Zahra SU et al.	72		28		35.54±2.5 3	36.17±2.9 6	32.39±2.2 1	32.05 ± 4.6
Joshi P et al.	88		6		32.84±8.4	34.46±8.1	31.85±1.8	31.67±2.8 3
Udaya P et al.	73.8 6	81.18	26.4	18.8 2	37.26±2.8 3	37.54±2.3 0	32.09±3.7 6	32.12±3.1 3
Mohan K et al.	42		58		36.58±2.38		34.74±4.0 8	-
Vinay G et al.	86.66		16.66		35.58		34.82	
Agarwal SA et al.	92.85		7.5		37.75 ±		32.96±6.06	
Lakshmi V et al.	58.82		41.17		37.4±2.61		33.7±3.32	
Roul B et al.	91.89		8.1		37.2		33.33	33.33
Gupta C et al.					37.75±3.4 5	37.68±1.6 1	34.66	34.83
Mazengeny a P et al.					37.12		31.45±2.5 2	31.87±3.6 3
Gupta RK et al.	63.9 7	58	36.0 3	42	36.1	36.44	32.66	33.09
Ankolekar VH et al.	91.6 6	88.46	8.33	11.5 4	37.3	38.7	35.92	34
Present study	66.0 3	65.95	33.9 6	34.0 4	36.3±2.5	36.8±2.2	33.15	32.39

CONCLUSION

In present study we found, Nutrient foramen was located mostly on the posterior surface and direction was downward. Nutrient artery is very important for blood supply of long bones. Therefore, it is very important for surgeons to have sound knowledge of precise morphology and morphometric of nutrient foramen which will help in preserving vasculature of bone during various surgical procedures like bone grafting, the knee replacement, external and internal fixation of fractures and bone resection for tumors.

REFERENCES

- Hiren S. Chavda, Nishita Jethva, Morphometric Study of Nutrient Foramen of Adult Human Tibia Bone Int J of Ana, Rad and Surg 2019;8(2):5-8
- Ankolekar VH, Quadros LS, D'souza AS. Nutrient foramen in tibia – A study in coastal region of Karnataka. IOSR-Jour of Dent & Med Sci. 2013;10(3):75-79.
- Standing S. Gray's Anatomy. The Anatomical basis of clinical practice. 40th edition. Elsevier Churchill Livingstone. 2008:1415.
- Truetta J. Blood supply and the rate of healing of the tibial fractures. Clin Orthop Relat Res. 1974;105:11-26.
- Mysorekar VR. Diaphyseal nutrient foramina in human long bones. J Anat. 1967;101(4):813-22.
- Kamath V, Asif M, Bhat S, Avadhani R. Primary nutrient foramina of tibia and fibula and their surgical implications. Indian J Clin Anat Physiol. 2016;3(1):41-44.
- Zahra SU, Kervancioğlu P, BahŞi i. Morphological and topographical anatomy of nutrient foramen in the lower limb long bones. Eur J Ther. 2018;24:36-43.
- Seema, Verma P, Mahajan A, Gandhi D. Variation in the number and position of nutrient foramina of long bones of lower limb in North Indians. Int J Anat Res. 2015;3(4):1505-09.
- Roul B, Goyal M. A study of nutrient foramen in long bones of inferior extremity in human being. Int. Jour of Adv Res. 2015;3(4):945-48.
- P Udaya Kumar, Rao JM, V Sirisha, T Kalpana. A study of the nutrient foramina in dry human tibia bones of telangana region. Int J Anat Res. 2017;5(3.1):4152-57.
- Joshi P, Mathur S. A comprehensive study of nutrient foramina in human lower limb long bones of Indian population in Rajasthan state. Galore International Journal of Health Sciences and Research. 2018;3(3),34-42.
- Prashanth KU, Murlimanju BV, Prabhu LV, Kumar CG, Pai MM, Dhananjaya KVN. Morphological and topographical anatomy of nutrient foramina in the lower limb long bones and its clinical importance. AMJ. 2011;4(10):530-37.
- Gupta RK, Gupta AK. A study of diaphyseal nutrient foramina in Human tibia. Natl J Med Res. 2014;4(4):310-13.
- Mazengeny P, Faremore MD. Morphometric studies of the nutrient foramen in lower limb long bones of adult black and white South Africans. Eur J Anat. 2015;19(2):155-63.
- Collipal E, Vergas R, Parra X, Silva H, Sol MD. Diaphyseal nutrient foramina in the femur, tibia, and fibula bones. Int J Morphol. 2007;25(2):305-08.
- Kizilkanat E, Boyan N, Ozashin ET, Soames R, Oguz O. Location, number and clinical significance of nutrient foramina in human long bones. Ann Anat. 2007;189(1):87-95.
- Pereira GAM, Lopes PTC, Santos AMPV, Silveira FHS. Nutrient foramina in the [12] upper and lower limb long bones. Morphometric study in bones of Southern Brazilian adults. Int J Morphol. 2011;29(2):514-20.
- Vadhel CR, Kulkarni MM, Gandotra AR. Anatomy of nutrient foramen of tibia-a study from Gujarat region. Indian J Clin Anat Physiol. 2015;2(1):6-10.
- Mohan K, Devaraj B, Ramanathan S, Rethinasamy M. Morphometric study of nutrient foramen in the long bones of lower limb. Int J Anat Res. 2017;5(2.3):3943-48.
- Agrawal N, Tiwari A, Parmar AS. Topography and indexing of nutrient foramina of tibia-a study in Vindhya region. Int J Med Sci Public Health. 2016;5:1000-04.
- G. Vinay, Gowri M. Anatomical study of the nutrient foramen of lower limb long bones in south Indian population. Indian J clin Anat Physiol. 2017;4(2):222-24.
- Gupta C, Nayak N, Kalthur SG, D'Souza AS. A morphometric study of tibia and its nutrient foramen in South Indian population with its clinical implications. Saudi J Sports Med. 2015;15:244-48.
- Ambekar S, Sukre SB. Diaphyseal nutrient Foramen of lower limb long bones: variations and Importance. Int J Anat Res. 2016;4(3):2684-88.