DOI: 10.7860/IJARS/2019/40637:2468

Original Article

Anatomy Section

Morphometric Study of Nutrient Foramen of Adult Human Tibia Bone

HIREN S CHAVDA[1], NISHITA K JETHVA[2]

ABSTRACT

Introduction: The position of nutrient foramen on the shaft of long bones is specific. It transmits nerve and vessels which help in maintaining nutrition of bone. Blood supply by nutrient artery is essential during early phases of ossification as well as during growing period which passes through the nutrient foramen.

Aim: To study the topography and location of nutrient foramen on the shaft of the tibia.

Materials and Methods: For the present study, 70 adult dry tibia of unknown age and sex were studied. The number, direction and location of nutrient foramen were noted. Using Hughes formula, foraminal index was calculated.

Results: A single nutrient foramen was present in all tibia. In all the bones they were directed downwards except in two bones where it was directed upwards. Nutrient foramen was situated on posterior surface except in two bones where it was on lateral surface of one bone and lateral border of other bone. Average total length of tibia was 35.11 cm while average distance of nutrient foramen from proximal end was 11.79 cm. In 45 tibia, foraminal index was <33.33 which indicates that in 64.28% of tibia foramen was on upper 1/3 of shaft.

Conclusion: The precise knowledge and topography of nutrient foramen of tibia will help surgeons and orthopaedicians in minimising damage to vasculature of tibia during various surgical procedures.

Keywords: Bone growth, Foraminal index, Nutrient artery

INTRODUCTION

The main source of arterial supply to long bone is derived from nutrient artery which enters the bone through nutrient foramen [1]. Nutrient foramen is generally directed away from the growing end of the bone [2]. In tibia, nutrient foramen is generally directed downwards because upper end is growing end, as it fuses with shaft in the 16th year in females and in the 18th in males. While lower-end fuses with the shaft at about 15th year in females and 17th year in males. Nutrient artery to tibia is a branch of posterior tibial artery. Sometimes it may arise from bifurcation of popliteal artery or anterior tibial artery [3]. Arterial supply from nutrient artery is vital especially during early embryogenic stages and periods of active bone growth [1]. Nutrient artery provides 70-80% of blood supply to the long bones in children and if the blood supply is decreased, it may lead to ischaemia of bone resulting into less vascularisation of metaphysis and growth plate [4]. It is very important for surgeons to have precise knowledge of nutrient foramina prior to surgery to ensure good success of surgical procedure and to improve prognosis [5]. 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 [6]. Therefore, this study was conducted to understand topography of nutrient foramen on tibial shaft.

MATERIALS AND METHODS

This was an observational cross-sectional study conducted in the Department of Anatomy, GMERS Medical College, Gandhinagar, Gujarat, India, from April 2018 to June 2018. Prior approval from the Central Research Committee of the institute was taken with registration no. GMERS/MCG/CRC/16/2018. For the study, 70 dry adult tibia of unknown age and sex were obtained from the department. Fully ossified and complete bones were included and bones with pathological changes or any kind of deformity were excluded from the study. Nutrient foramina which allowed the passage of size 24 gauge needle were considered as primary nutrient foramen [7]. Other smaller foramina which did not allow the passage of the needle were not included [8]. Nutrient foramen was identified by presence of a groove and a raised margin at its beginning and its direction were determined by passing the needle into the foramen.

Side determination of bones was done and following parameters were observed and measurements were taken with the help of osteometric board and vernier calliper.

(1) Number of primary nutrient foramen

(2) Direction of the foramen

(3) Surface of the shaft where the nutrient foramen is located

(4) Location of nutrient foramen on posterior surface of shaft– medial to vertical line, lateral to vertical line, on the vertical line

(5) Distance of nutrient foramen from proximal end of tibia (PF) (as shown in [Table/Fig-1]): measured by vernier calliper

(6) TL (Total length of tibia) (as shown in [Table/Fig-2]): measured by osteometric board.

[Table/Fig-1]: Distance of nutrient foramen from proximal end of tibia (PF).
[Table/Fig-2]: Total length of tibia (TL). (Images left to right)

(7) Foraminal Index– Foraminal index was obtained by using Hughes Formula [9].

Foraminal index = PF/TL×100

On the basis of foraminal index, location of foramen was determined as follows [10]:

(i) Foraminal index <33.33 indicates that the foramen is in the upper 1/3 of the bone;

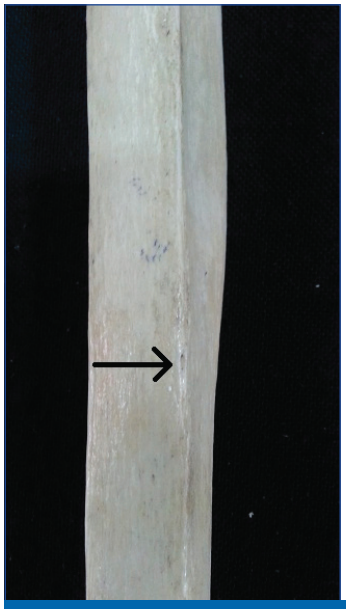
(ii) Foraminal index between 33.33 and 66.66 indicates that the foramen is in the middle 1/3 of the bone;

(iii) Foraminal index >66.66 indicates that the foramen is in the lower 1/3 of the bone;

Observations were tabulated in Microsoft Excel worksheet and average total tibial length, average distance of nutrient foramen from proximal end of tibia and foraminal index were calculated.

RESULTS

In the present study, all the bones showed presence of a single nutrient foramen. It was directed downwards and was located on the posterior surface of shaft in most of the bones. In one tibia, it was located on the lateral border [Table/Fig-3] and in the other; it was located on the lateral surface [Table/Fig-4]. In two bones, it was directed upwards.



[Table/Fig-3]: Nutrient foramen on lateral border of shaft.
[Table/Fig-4]: Nutrient foramen on lateral surface of shaft. (image left to right)

Number, direction, surface, location on posterior surface of shaft, average Total Length (TL), average distance of nutrient foramen from Proximal End (PF), Foraminal Index (FI), location of foramen on the basis of foraminal index are shown in [Table/Fig-5,6].

Nutrient foramen		Right	Left	Total
Number	Single	35	35	70
	Double	0	0	0
Direction	Downward	34	34	68
	Upward	1	1	2
Surface on shaft	Posterior surface	34	34	68
	Lateral surface	0	1	1
	Medial surface	0	0	0
	Lateral border	1	0	1

[Table/Fig-5]: Showing number, direction and location of nutrient foramen on tibia.

The average total length of tibia was 35.11 cm. The average distance of nutrient foramen from the highest point on the proximal part of bone was found to be 11.79 cm. Foraminal index was <33.33 in 45 tibia. This indicates that in majority of bones, foramen is present on the upper 1/3 of the bone [Table/Fig-7].

	Right	Left	Total
Location of Nutrient foramen on posterior surface of shaft	34	34	68
Lateral to vertical line	29	32	61
Medial to vertical line	1	1	2
On vertical line	3	1	4
On soleal line	1	0	1

[Table/Fig-6]: Showing location of nutrient foramen on posterior surface of shaft of tibia.

Parameter		Right	Left	Total
Average total length of tibia (TL) (in cm)		35.07	35.14	35.11
Average distance of nutrient foramen from proximal end (PF) (in cm)		11.79	11.80	11.79
Number and percentage of bones showing Location of nutrient foramen on the shaft: On the basis of Foraminal index	Upper 1/3	22 (62.85%)	23 (65.71%)	45 (64.28%)
	Middle 1/3	13 (33.14%)	12 (34.28%)	25 (35.37%)
	Lower 1/3	0	0	0

[Table/Fig-7]: Showing average TL, PF and Location of nutrient foramen on the shaft on the basis of Foraminal index.
TL: Total length of tibia; PF: Distance of nutrient foramen from proximal end

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 ischaemia which will lead to interference with healing process. Therefore, anatomical knowledge of nutrient artery is crucial prior to surgery. In the present study, findings are compared with other studies published in literature [Table/Fig-8,9] [2,6,7,11-27].

In the present study, a single nutrient foramen was observed in all the tibia. Many authors also found single nutrient foramen in most of the bones [2,6,7,11-19,21-23]. Double nutrient foramina were found in very few numbers of bones in the studies done by other authors. Roul B et al., reported double foramina in 16.20% cases while Udaya P et al., reported 13.51% and 10.39% of double foramina on right and left sides respectively [20,24]. These findings were slightly higher than that of other authors who also found two nutrient foramina [2,7,11,12,14-17,22,23]. Three foramina were observed by Swapna SA et al., (3.80%) and Udaya P et al., (2.70%) in their studies [22,24]. Joshi P et al., observed absent nutrient foramen in 6% of cases [25]. Prashanth KU et al., and Zahra SU et al., observed absent nutrient foramen in 1.4% and 1.96% of tibia respectively [13,26]. Gupta RK and Gupta AK, also found 1.86% bones of right side and 4.34% bones of left side with absent nutrient foramen [15]. Nutrition of bones in cases of absent nutrient foramen is derived from periosteal vessels [3].

In most of the tibia, nutrient foramen was directed downwards in the present study. This finding was in accordance with studies conducted by most of the authors [6,7,14,18,21,23,24,26,27]. Authors found two bones in which foramen were directed upwards. 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 [17]. During development, initially, all nutrient arteries run in caudal direction in the embryonic period. Then because of the differences in the growth of ends of the long bones of the limbs, nutrient artery is directed away from the growing end [28]. However, this was not true in case of mammals as reported by Hughes H, and Henderson RG [9,29].

In the present study, nutrient foramen was observed on posterior surface of shaft of most of the tibia except in two bones. It was located on the lateral surface in one bone and on the lateral border of another bone. Most of the authors also have reported the location of foramen on posterior surface in most of the bones [2,6,7,12-14,16,18,21,23,24,26,27]. Kamath V et al., observed foramen on medial surface in 2.82% of bones [6]. Mysorekar VR found 74% of

Author, Population studied and year of study	Sample size	Number of Nutrient foramen (% of bones)							
		One		Two		Three		Absent	
		Right	Left	Right	Left	Right	Left	Right	Left
Sharma M et al., [2]	50 (right-25, left-25)	96		4		-	-	-	-
Kamath V et al., (Mangalore) [6]	71 (right-33, left-38)	100		-		-	-	-	
Mohan K et al., [7]	150	98		2		-	-	-	
Kizilkanat E et al., (Turkish) [11]	100	98		2		-	-	-	-
Pereira GAM et al., (Brazil) [12]	142	98.60		1.40		-	-	-	-
Prashanth KU et al., (Mangalore) [13]	69 (right-32, left-37)	98.6		-		-	-	1.4	
Ankolekar VH et al., (Karnataka) [14]	50	98		0	2	-	-	-	-
Gupta RK et al., (Gujarat) [15]	312 (right-161, left-151)	97.51	94.70	0.62	-	-	-	1.86	4.34
Seema et al., (North India) [16]	60 (right-30, left-30)	93.34	96.67	6.60	3.30	-	-	-	-
Mazengenya P et al (South African black people) [17]	180 (right-90, left-90)	99.40		0.60		-	-	-	-
Mazengenya P et al., (South African white people) [17]	180 (right-90, left-90)	98.30		1.70		-	-	-	-
Vadhel CR et al., (Gujarat) [18]	188 (right-94, left-94)	100		-	-	-	-	-	-
Gupta C et al., (South India) [19]	50 (right-24, left-26)	100		-	-	-	-	-	-
Roul B et al., (Raipur) [20]	37	83.70		16.20		-	-	-	-
Agarwal SA et al., (Vindhya region) [21]	80 (right-40, left-40)	100		-	-	-	-	-	-
Swapna SA et al., (Aurangabad) [22]	-	94.30		1.90		3.80		-	-
Vinay G et al., (South India) [23]	90 (right-45, left-45)	96.66		3.33		-	-	-	-
Udaya P et al., (Telangana) [24]	151(right-74, left-77)	83.70	89.61	13.51	10.39	2.70		-	-
Joshi P et al., (Rajasthan) [25]	50 (right-21, left-29)	94		-	-	-	-	6	
Zahra SU et al., (Turkey) [26]	91(right-40, left-51)	97.5	96.07	2.5	1.96	-	-	1.96	
Present Study	70 (right-35, left-35)	100	100	-	-	-	-	-	-

[Table/Fig-8]: Showing comparison of Number of Nutrient foramen with other studies (Values are expressed as percentage) [2,6,7,11-26].

Author, Population studied and year of study	Sample size	Mean length (cm)		Foraminal index (cm)		Location of Nutrient foramen (% of bones)			
						Upper 1/3		Middle 1/3	
		Right	Left	Right	Left	Right	Left	Right	Left
Kamath V et al., [6]	71 (right-33, left-38)	-		32.08		74.65		25.35	
Mohan K et al., [7]	150	36.58±2.38		34.74±4.08	-	42		58	
Kizilkanat E et al., [11]	100	35.8		31.2		-	-	-	-
Pereira GAM et al., [12]	142	37.31		32.9±6	32.3±2.8	-	-	-	-
Prashanth KU et al., [13]	69 (right-32, left-37)	-		32.5		98.3 (upper 2/5th)		1.7 (3/5th)	
Ankolekar VH et al., [14]	50	37.3	38.7	35.92	34	91.66	88.46	8.33	11.54
Gupta RK et al., [15]	312 (right-161, left-151)	36.1	36.44	32.66	33.09	63.97	58	36.03	42
Seema et al., [16]	60 (right-30, left-30)	35.16±2.65	34.9±2.71	-	-	99.5		0.5	
Mazengenya P et al., [17]	180 (right-90, left-90)	38.44		31.45±2.52	31.87±3.63	-	-	-	-
Mazengenya P et al., [17]	180 (right-90, left-90)	37.12		31.45±2.52	31.87±3.63	-	-	-	-
Vadhel CR et al., [18]	188 (right-94, left-94)	-	-	-	-	99.5		0.5	
Gupta C et al., [19]	50 (right-24, left-26)	37.75±3.45	37.68±1.61	34.66	34.83	-	-	-	-
Roul B et al., [20]	37	37.2		33.33	33.33	91.89		8.1	
Agarwal SA et al., [21]	80 (right-40, left-40)	37.75 ± 3.32		32.96±6.06		92.85		7.5	
Swapna SA et al., [22]	-	36.19		-	-	100		-	-
Vinay G et al., [23]	90 (right-45, left-45)	35.58		34.82		86.66		16.66	
Udaya P et al., [24]	151 (right-74, left-77)	37.26±2.83	37.54±2.30	32.09±3.76	32.12±3.13	73.86	81.18	26.4	18.82
Joshi P et al., [25]	50 (right-21, left-29)	32.84±8.4	34.46±8.1	31.85±1.8	31.67±2.83	88		6	
Zahra SU et al., [26]	91 (right-40, left-51)	35.54±2.53	36.17±2.96	32.39±2.21	32.05 ± 4.6	72		28	
Lakshmi V et al., [27]	50 (right-27, left-23)	37.4±2.61		33.7±3.32		58.82		41.17	
Present Study	70 (right-35,left-35)	35.1±2.3	35.2±1.96	33.8±5.43	33.5 ± 5.56	62.85	65.71	33.14	34.28

[Table/Fig-9]: Showing comparison between Mean length and Foraminal index (Values are expressed in centimeters) and Location of Nutrient foramen according to Foraminal index (Values are expressed in Percentage) with other studies.

bones into which foramen was located on posterior surface [28]. In their study on black and white South Africans, Mazengenya P and Feremore MD, reported slightly less occurrence of nutrient foramen on posterior surface, 75.6% and 77.8% respectively [17].

Regarding location of nutrient foramen on posterior surface of shaft, it was observed by most of the authors that it is located below the soleal line. This finding was similar to the present study. Authors found only one bone in which nutrient foramen was located on the soleal line. Below the soleal line, 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 in the present study. Seema et al., and Collipal E et al., found 3.77% and 4% of tibia having

nutrient foramen on the soleal line [16,30]. Seema et al., [16] also reported 0.50% of bones having foramen on lateral border. In the present study, Total Length of tibia (TL) was found to be 35.1±2.3 cm on right side and 35.2±1.96 cm on the left side. The present findings were similar to other authors [Table/Fig-9]. Mazengenya P and Faremore MD, observed average tibial length to be 38.44 cm in black South Africans and 37.12 cm in white South Africans which was slightly higher than the present study [17]. Kizilkanat E et al., observed it be 35.8 cm in Turkish population and Pereira GAM et al., found it to be 37.31 cm [11,12].

Average distance of nutrient foramen from proximal end (PF) was found to be 11.8±1.93 cm on right side and 11.8±2.28 cm on left side in the present study. Ankolekar VH et al., found this value to be 13 cm and 13.4 cm on the right and left side respectively [14]. Joshi P and Mathur S, in their study on Rajasthani population, reported this distance as 14.53±3.77 cm on right side while 14.0±2.99 cm on left side [25]. In 45 tibia, Foraminal Index (FI) was found to be <33.33 in the present study, which indicates that 64.28% of nutrient foramina were located on upper 1/3 of tibia while it was between 33.33 to 66.66 in 25 bones which indicates that in 35.37% of bones it was in the middle 1/3. Gupta RK and Gupta AK, also observed similar findings in Gujarati population [15]. 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]. Bhojaraja VS et al., documented that in 58.82 % of tibia, nutrient foramen is on upper 1/3 while in 41.17% of cases, it is in the middle 1/3 [27]. Kamath V et al., reported nutrient foramen in upper1/3 in 74.65% of bones and in middle1/3 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 1/3 more than on the middle1/3 [12,17]. Mohan K et al., found it on upper 1/3 in 42% of bones while in 52%, it was on middle 1/3 [7]. No foramen was found in the lower 1/3rd of the tibia.

LIMITATION

This study was conducted on 70 bones only, which was small sample for the study. Authors could not incorporate more bones because of resources limitations in the department. Bones available in the department were of unknown age and sex, therefore gender and age-based assessment were also not done in the present study. Further larger studies involving more bones of known age and sex from different geographical regions are advised to have more detailed knowledge on the subject.

CONCLUSION

In tibia, nutrient foramen is situated mostly on the posterior surface. Nutrient artery is essential for blood supply of long bones. Therefore it is very important for surgeons to have sound knowledge of precise topography of nutrient foramen which will help in preserving vasculature of 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 postoperative complications, as well as this will also help in better outcome of operative procedure.

REFERENCES

[1] Lewis OJ. The blood supply of developing long bones with special reference to the Metaphyses. J Bone Joint Surg Br.1956;38(B):928-33.
[2] Sharma M, Prashar R, Sharma T, Wadhwa A, Kaur J. Morphological variations of nutrient foramina in lower limb long bones. Int J Med and Dent Sci. 2015;4(2):802-08.
[3] Standring S. Gray's Anatomy. The Anatomical basis of clinical practice. 40th edition.Elsevier Churchill Livingstone. 2008:1415.
[4] Truetta J. Blood supply and the rate of healing of the tibial fractures. Clin Orthop Relat Res. 1974;105:11-26.
[5] Taylor GI. Fibular transplantation. In: Serafin D, Bunke HJ (eds), Microsurgical composite tissue transplantation, C.V. Mosby Co., St. Louis, 1979:418-23.
[6] 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.
[7] 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.
[8] Lee JH, Ehara S, Tamakawa Y, Horiguchi M. Nutrient canal of the fibula. Skeletal Radiol. 2000;29:22-26.
[9] Hughes H. The factors determining the direction of the canal for the nutrient artery in the long bones of mammals and birds. Acta Anat (Basel). 1952;15(3):261-80.
[10] Ukoha UU, Umeasalugo KE, Nzeako HC, Ezejindu DN, Ejimofor OC, Obazie IF. A study of nutrient foramina in long bones of Nigerians. Natl J Med Res.2013;3:304-08.
[11] 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.
[12] Pereira GAM, Lopes PTC, Santos AMPV, Silveira FHS. Nutrient foramina in the upper and lower limb long bones. Morphometric study in bones of Southern Brazilian adults. Int J Morphol. 2011;29(2):514-20.
[13] 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.
[14] 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.
[15] Gupta RK, Gupta AK.A study of diaphyseal nutrient foramina in Human tibia. Natl J Med Res. 2014;4(4):310-13.
[16] 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.
[17] Mazengenya 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.
[18] 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.
[19] 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.
[20] 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.
[21] 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.
[22] Ambekar SA, Sukre SB. Diaphyseal nutrient Foramen of lower limb long bones: variations and Importance. Int J Anat Res. 2016;4(3):2684-88.
[23] 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.
[24] 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.
[25] 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.
[26] 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.
[27] Bhojaraja VS, Kalthur SG, D' Souza AS. A study of Diaphyseal Nutrient Foramina in human lower limb long bones and its clinical importance. Int J Curr Res Med Sci. 2016;2(7):1-12.
[28] Mysorekar VR. Diaphyseal nutrient foramina in human long bones. J Anat. 1967;101(4):813-22.
[29] Henderson RG. The position of the nutrient foramen in the growing tibia and femur of the rat. J Anat. 1978;125:593-99.
[30] Collipal E, Vergas R, Parra X, Silva H, Sol MD. Diaphyseal nutrient foramina in the femur, tibia, and fibula bones. Int J Morphhol. 2007;25(2):305-08.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Anatomy, GMERS Medical College, Gandhinagar, Gujarat, India.
2. Tutor, Department of Anatomy, GMERS Medical College, Gandhinagar, Gujarat, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Nishita K Jethva,
Tutor, Department of Anatomy, GMERS Medical College, Gandhinagar, Civil Hospital Campus,
Sector-12, Gandhinagar-382012, Gujarat, India.
E-mail: nishi.jethva@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Dec 18, 2018**
Date of Peer Review: **Dec 31, 2018**
Date of Acceptance: **Jan 22, 2019**
Date of Publishing: **Apr 01, 2019**