

Cadaver Study on Variation of Nutrient Foramina of Adult Human Humeri in Bangladeshi Population

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Abstract

The nutrient foramen is an opening in the bone shaft which allows passage to the blood vessels of the modularly cavity of a bone for its nourishment and growth. Nutrient artery is the major source of blood supply to bone and it plays an important role in healing of fracture and trauma and is also important for bone grafting. This cross-sectional, descriptive cadaver based study aims to determine the presence, direction, common location, position and number of nutrient foramen of adult human humerus in a Bangladeshi population. One hundred samples (43 on right and 57 on left) were selected through the purposive sampling technique which was carried out in the Department of Anatomy, Mymensingh Medical College, Bangladesh, from July 2021 to June 2022. Any damaged, unossified bones or fractured bones were excluded. The presence of nutrient foramina was observed in the shaft of the humeri. Data were recorded and tabulated to analyze using Microsoft Excel and SPSS software. Nutrient foramina was found in all the samples on both sides. So nutrient foramina present on the right side was 100% and on the left side was 100%. The direction of nutrient foramina towards the elbow joint was found in all the samples of both sides. Among 43 right humeri, 37(75.51%) have single-nutrient foramen and 06(24.49%) have double-nutrient foramina. Among 57 left humeri, 53(92.98%) have single nutrient foramen, 03(5.27%) have double nutrient foramina and 01(1.75%) has triple nutrient foramina. In case of location of nutrient foramina, among 49 right nutrient foramina, 45(91.84%) were found on the anteromedial surface, 02(4.08%) were found on the anterolateral surface and 02(4.08%) were on the posterior surface of the shaft of the humerus. In case of 62 left nutrient foramina, 57(91.94%) were found on the anteromedial surface and 05(8.06%) were found on the posterior surface of the shaft of the humerus. In case of position of nutrient foramina, among 49 right nutrient foramina, 01(2.04%) was found on the upper third, 46(93.88%) on the middle third and 02(4.08%) on the lower third of the shaft of the humerus. In case of 62 left nutrient foramina, 01(1.60%) was on the upper third, 57(91.95%) were on the middle third and 04(6.45%) were on the lower third of the shaft of the humerus.

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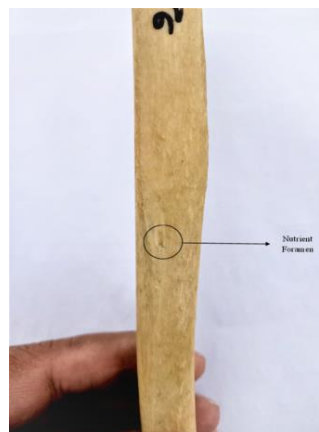
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Introduction

Bone is a highly vascular mineralized connective tissue which performs numerous vital functions in the human body. The blood supply to the bones varies according to the shape of the bone.¹ Nutrient foramen is an opening in the shaft of the humerus. It steers to oblique nutrient canal passing through cortex and finally open into the medullary cavity.² The nutrient artery enters into medullary cavity through nutrient foramen and the canal which is major source of blood supply to medullary cavity and inner two-third of cortex of the bone.³ The major blood supply for long bones originates from the nutrient arteries, mainly during the growing period and during the early phases of ossification.⁴ The absence of nutrient foramina and hence the nutrient artery can deplete the blood supply to the ossifying bones and can result in ischemia of the metaphysis and growth plate.^{5,6} Apart from this, injury to the nutrient artery at the time of fracture, or during subsequent manipulation and surgery may be a significant predisposing factor for faulty union of long bones.⁷ Non-union of the humeral shaft remains a difficult clinical problem as the healing of fractures is dependent upon blood supply.^{8,9} The direction, number, location and position of nutrient foramina may vary. In the humerus, the nutrient foramen is commonly present slightly below the midpoint of the anteromedial surface (AMS) close to the medial border (MB) and is directed downwards.^{3,10} Knowledge of the presence, direction, number, location and position of the nutrient foramina in the humerus is not only important in understanding the physiology of the development of bone but also is of significance in the healing of fractured bones and orthopedic surgeries. In the present

investigation, we wanted to assess whether there is any variation among the Bangladeshi population with respect to the presence, direction, number, position and location of nutrient foramina in the humerus.

Fig. 1: Photograph showing nutrient foramen of the human humerus.



Methods

The cross-sectional, descriptive cadaver based study was conducted from July 2021 to June 2022 in the Department of Anatomy, Mymensingh Medical College, Mymensingh, Bangladesh. One hundred (100) fully ossified dry human humeri were collected for the study from cadavers. A non-random, purposive sampling technique was used for sample selection. The sample was excluded if the bones were unossified, developmentally abnormal, and broken. The nutrient foramen was identified by the presence of a well-marked groove, often a slightly raised edge at the commencement of the canal. Only the shaft's nutrient foramen of the humerus was observed in this study. A fine metallic pin was passed through each foramen to confirm their patency. The presence or absence of nutrient foramina was observed macroscopically and noted accordingly. The direction of nutrient

foramina either towards the upper end or towards the lower end was observed by introducing a metallic pin. The number, location, and position of nutrient foramina in relation to specific borders or surfaces of the shaft were observed. The number of nutrient foramina was counted in each bone. The position was made out of whether it was present on the upper, middle, or lower one-third of the bone. The location of nutrient foramina was observed in relation to the surface of the shaft of the humerus. Data were recorded and tabulated to analyze using Microsoft Excel and SPSS software (version 23.0). The study was approved by the Ethical Review Committee of Mymensingh Medical College, Mymensingh, Bangladesh.



Fig. 2: Photograph showing position (middle 3rd of the shaft) and location (anteromedial surface of shaft) of nutrient foramen of the humerus



Fig. 3: Photograph showing position (lower 3rd of the shaft) and location (anteromedial surface of shaft) of nutrient foramen of the humerus

Results

In the present study, the number of nutrient foramina was observed. Nutrient foramen was found in all the samples on both sides (Table-I).

The directions of nutrient foramina was observed. The directions of nutrient foramina towards the elbow joint was found in all the samples of both sides (Table-II). Out of 43 right humeri, nutrient foramina were present in all of the samples. Among them, 37(75.51%) had single-nutrient foramen and 6(24.49%) had double-nutrient foramina. Out of 57 left humeri, nutrient foramina were present in all of the samples. Among them, 53(92.98%) had single nutrient foramen, 3(5.27%) had double nutrient foramina and 1(1.75%) had triple nutrient foramina (Table-III). In case of the location of the nutrient foramina, at right sided humeri, 45(91.84%) were found on the anteromedial surface, 2(4.08%) were found on the anterolateral surface and 2(4.08%) were on the posterior surface of the shaft of the humerus, while at left side, 57(91.94%) were found on the anteromedial surface and 5(8.06%) were found on the posterior surface of the shaft of the humerus (Table-IV). Among 49 right nutrient foramina, 1(2.04%) was found on the upper third, 46(93.88%) were found on the middle third, and 2(4.08%) on the lower third of the shaft of the humerus. In the case of 62 left nutrient foramina, 1(1.60%) foramen was found on the upper third, 57(91.95%) were on the middle third and 4(6.45%) were on the lower third of the shaft of the humerus (Table-V).

Table-I: Presence of Nutrient Foramen

Presence of nutrient foramen	Right		Left	
	Frequency	Percent (%)	Frequency	Percent (%)
Present	43	100	57	100
Absent	00	00	00	00
Total	43	100	57	100

Table-II: Directions of Nutrient Foramina

Direction of nutrient foramina	Right		Left	
	Frequency	Percentage	Frequency	Percentage
Toward the elbow joint	49	100	62	100
Away from the elbow joint	00	00	00	00
Total	49	100	62	100

Table-III: Number of Nutrient Foramina

Number of nutrient foramina	Right		Left	
	Frequency	Percentage	Frequency	Percentage
One (1)	37	75.51	53	92.98
Two (2)	06	24.49	03	5.27
Three (3)	00	00	01	1.75
Total	43	100	57	100

Table-IV: Locations of Nutrient Foramina

Location of nutrient foramina	Right		Left	
	Frequency	Percent (%)	Frequency	Percent (%)
Anteromedial surface	45	91.84	57	91.94
Anterolateral surface	02	4.08	00	00
Posterior surface	02	4.08	05	8.06
Total	49	100	62	100

Table- V: Incidence of Different Position of Nutrient Foramina

Position of nutrient foramina	Right		Left	
	Frequency	Percent (%)	Frequency	Percent (%)
Upper 1/3	01	2.04	01	1.60
Middle 1/3	46	93.88	57	91.95
Lower 1/3	02	4.08	04	6.45
Total	49	100	62	100

Discussion

According to the present study, nutrient foramen was found in all the samples on both sides. So, nutrient foramen was present on the right side and the left side was 100%. Chaudhary *et al.*¹¹ conducted a study on 59 (right=27; left=32) humeri and observed nutrient foramen. Nutrient foramen presents in all sample which was similar to present study. In the present study directions of nutrient foramina were observed on both sides. In all cases, nutrient foramina were found to be directed towards its lower end. Similar observations were made by Chaudhary *et al.*, Zichao *et al.*, Ali EK, Manjunath & Pramod and Challa & Nanna.¹¹⁻¹⁵ In the present study, the number of nutrient foramina was observed. Out of 43 right humeri, nutrient foramen was present in all of the samples. Among them, 37(75.51%) have single-nutrient foramen and 6(24.49%) have double-nutrient foramen. Out of 57 left humeri, nutrient foramen was present in all of the samples. Among them, 53(92.98%) have single nutrient foramen, 3(5.26%) have double nutrient foramen and 1(1.75%) has triple nutrient

foramen. Chaudhary *et al.* and Sintakala & Manandhar conducted a study and found that single nutrient foramen on the right side was 85.18% and 87.8% respectively which was higher than the present study.^{11,16} But Singh *et al.* and Khandve & Verma found 65.62% and 58% respectively which was lower than the present study.^{17,18} Singh *et al.* and Khandve & Verma conducted a study and found that double nutrient foramen on the right side was 34.37% and 40% respectively which was higher than the present study.^{17,18} But Chaudhary *et al.* and Sintakala & Manandhar found 14.81% and 6.8% respectively which was lower than the present study.^{11,16} Sintakala & Manandhar conducted a study and found that triple nutrient foramen on the right side was 5.4% which was lower than the present study.¹⁶ Singh *et al.*, Khandve & Verma, Chaudhary *et al.* and Sintakala & Manandhar conducted a study and found that single nutrient foramen on the left side was 56.67%, 70%, 81.28% and 61.9% respectively which was lower than the present study.^{17,18,11,16} Singh *et al.*, Khandve & Verma, Chaudhary *et al.* and Sintakala & Manandhar conducted a study and found that double nutrient foramen on the left side was 26.67%, 29.0%, 15.62% and 31.0% respectively which was higher than the present study.^{17,18,11,16} Sintakala & Manandhar found triple nutrient foramen only in 4.0% of cases of their study which was higher than this study. However, Singh *et al.* found 16.66% which was higher than the present study.^{16,17} Chaudhary *et al.* found 1.69% of cases which were nearly similar to this study.¹¹ According to this study, various locations of nutrient foramina were observed. Out of 49 right nutrient foramina, 45(91.84%) were found on the anteromedial surface, 2(4.08%) were found on the anterolateral

surface and 2(4.08%) were on the posterior surface of the shaft of the humerus. In the case of 62 left nutrient foramina, 57(91.94%) were found in the anteromedial surface and 05(8.06%) were found in the posterior surface of the shaft of the humerus. Singh *et al.* conducted a study and found that the location of nutrient foramina on the anteromedial surface of right-sided humeri was 70.58% which was lower than the present study.¹⁷ However, this incidence on the anterolateral surface of the right-sided humeri was lower than Singh *et al.* 11.76%.¹⁷ The incidence of the present study regarding the location of nutrient foramina on the posterior surface of the right-sided humeri was lower than Singh *et al.* 17.74%.¹⁷ Singh *et al.* found the location of nutrient foramina on the anteromedial surface of left-sided humeri as 68.42% which was lower than this study.¹⁷ However, this incidence on the anterolateral surface of the left-sided humeri was 11.76% in the study of Singh *et al.* and absent in this study.¹⁷ The incidence of this study was regarding the location of nutrient foramina on the posterior surface of the left-sided humeri was lower than Singh *et al.* 13.15%.¹⁷ According to the present study, there were various positions of nutrient foramina. Among 49 right nutrient foramina, 1(2.04%) was found on the upper third, 46(93.88%) were found on the middle third, and 2(4.08%) on the lower third of the shaft of the humerus. In the case of 62 left nutrient foramina, 1(1.60%) foramen was found on the upper third, 57(91.95%) were on the middle third and 4(6.45%) were on the lower third of the shaft of the humerus. Chaudhary *et al.* conducted a study and found that the position of nutrient foramina on the upper third of the right-sided shaft of humeri was 3.70% which was higher than the present study.¹¹ But on the left

side, which was found absent by Chaudhary *et al.* on the upper third of the humerus.¹¹ The incidence of the present study regarding the position of nutrient foramina on the middle third of the both-sided shaft of the humeri was higher than Chaudhary *et al.* at 88.90% on the right and 87.0% on the left-sided humeri.¹¹ The incidence of this study regarding the position of nutrient foramina on the lower third of both-sided shafts of the humeri was lower than Chaudhary *et al.* at 7.40% on the right and 12.50% on the left-sided humeri.¹¹

Conclusion

In our study, nutrient foramen was found in all the samples on both sided humeri. All the nutrient foramina were directed towards elbow joint. The direction of these foramina is always constant which is away from the growing ends. This study concludes that the nutrient foramina of the humeri were not only located on the anteromedial surfaces but also the anterolateral and posterior surfaces of the shaft of the humerus. The knowledge about the location of the nutrient foramen and their variation will be helpful for orthopedic surgeon to decrease the chances of damage to the nutrient artery during open or close surgical procedures. Similarly, the nutrient foramen of the humerus was found on both the middle and the lower third of the shaft. Most of the humeri had a single nutrient foramen, though some had more than one foramen. This type of study will help in surgical procedure of fracture, trauma and will give knowledge about variation of nutrient foramina present, so that operator may not confused during operation. This study recorded data related to the population of Bangladesh, providing ethnic data to be used for

comparison and that may help in surgical procedures and in the interpretation of radiological images.

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