ORIGINAL ARTICLE

JOURNAL OF AD-DIN AKIJ MEDICAL COLLEGE

Vol. 4 | No. 1 | January 2025
JAAMC 2025; 4(1): 11−17

Variation in Number, Position, and Direction of Nutrient Foramen of Clavicle and Their Relationship with Side and Gender in Bangladesh

***Afrin Jahan Munni[1], Shanila Khanom[2], Md Alamin Sheikh[3], Shaon Akter Nipu[4], Fatima Jomrud Mohol[5]**

1. Assistant Professor, Department of Anatomy, Ad-din Akij Medical College, Khulna.
2. Assistant Professor, Department of Anatomy, Barind Medical College, Rajshahi.
3. Assistant Professor, Department of Anatomy, North Bengal Medical College, Sirajganj.
4. Assistant Professor, Department of Pharmacology & Therapeutics, Ad-din Akij Medical College, Khulna.
5. Associate Professor and Head, Department of Anatomy, Rajshahi Medical College, Rajshahi.

***Correspondence**

Dr. Afrin Jahan Munni
MBBS, MPhil (Anatomy)
Assistant Professor,
Department of Anatomy
Ad-din Akij Medical College, Khulna.
Cellphone no. +88017-46240450
email: afrinjahan18@gmail.com

Received: 26 Oct 2024
Accepted: 04 Nov 2024

Abstract

Background: *The clavicle is an atypical long bone of the pectoral girdle. The shaft of the clavicle usually presents one nutrient foramen for the passage of the nutrient artery which is the main source of artery supply of clavicle. The position, number, and direction of the nutrient foramen of the clavicle are not constant.* ***Objectives:*** *This study aimed to determine the variation in the number, position, and direction of the clavicle and their relationship with side and gender.* ***Methods:*** *This cross-sectional type of descriptive study was conducted over 1 year from January 2022 to December 2022 in the Department of Anatomy, Rajshahi Medical College, Rajshahi. This study was performed on 350 dry adult human clavicles (225 were male and 125 were female clavicles) which were collected from the students of the Department of Anatomy, Rajshahi Medical College, Rajshahi as well as other Medical Colleges after fulfilling the inclusion criteria. Data were collected purposively with the help of a semi-structured questionnaire. All the measurements were performed using a magnifying lens, guide wire, and 24-hypodermic needle (0.56 mm in diameter). Data were analyzed by SPSS software, version 24.0, and a p-value < 0.05 was considered statistically significant for all tests.* ***Results:*** *The study revealed that among 350 dry adult clavicles, 196 (56%) were right-sided and 154 (44%) were left-sided. 251 (71.70%) of the clavicles showed single foramen, 85 (24.30%) double, and 8 (2.30%) triple nutrient foramen. 359 (80.67%) of the nutrient foramina were on the posterior surface, 79 (17.75%) on the inferior surface, 5 (1.12%) on the superior surface, and only 2 (0.45%) on the anterior surface of the dry adult clavicles. All the nutrient foramina was directed towards the acromial end. The relationship of the position and number of neurovascular foramina between the right and left-sided and between the male and female adult human clavicles were found statistically non-significant (p > 0.05).* ***Conclusion:*** *Information about the nutrient foramen is of great clinical importance, especially in surgical procedures like microvascularised bone transplantation and bone grafting.*

Keywords: number, position, and direction of nutrient foramen.

Introduction

The clavicle or collarbone is the only long bone that lies more or less in the horizontal plane. It differs from the other long bones as it has no medullary cavity (1). The clavicle is an atypical long bone of the pectoral girdle and is subcutaneous throughout its length. It transmits the weight of the body from the appendicular skeleton to the axial skeleton. Most of the parts of the clavicle develop by intra-membranous ossification. Its lateral or acromial end forms the acromioclavicular joint so that the arm can swing easily away from the trunk (2). The bone has a cylindrical part called the shaft, with two ends, lateral and medial. The shaft is divided into the medial two-thirds and the lateral one-third (3). The medial two-thirds of the shaft is almost rounded and has four surfaces. The anterior surface is convex forward, and the posterior surface is smooth. The superior surface is rough in its medial part and the inferior surface has a rough oval impression at the medial end. The lateral half of the inferior surface has a longitudinal subclavian groove for insertion into the subclavius muscle. The nutrient foramen lies at the lateral end of the subclavian groove. The medial or sternal end articulates with the clavicular notch of the manubrium sterni to form the sternoclavicular joint. The articular surface of the medial end extends to the inferior aspect for articulation with the first costal cartilage (3).

The lateral third is flattened from above downward and has two surfaces, superior and inferior, limited by the anterior and posterior border. Close to the posterior border, at the junction of the lateral fourth with the rest of the bone, there is a prominent conoid tubercle which gives attachment to the conoid part of the coracoclavicular ligament (4). Lateral end bears a facet that articulates with the acromion process of the scapula to form the acromioclavicular joint.

Usually, the clavicle contains one nutrient foramen for the entry of the nutrient artery present in the shaft (5). The nutrient foramen is directed away from the growing end as a rule that is towards the acromial end of the clavicle. The nutrient artery is the key source of blood supply to a long bone which enters the shaft of the bone along with the nerves through the nutrient foramen during its growth period. The nutrient foramen develops naturally during the growth of the fetus. The nutrient artery originates from the clavicular branch of a suprascapular artery or acromiothoracic artery (6). In one study it was published that the clavicle is supplied by the periosteal arteries and is devoid of nutrient artery (7).

Moreover, it has great clinical importance as the clavicle is commonly fractured at the junction of the medial two-thirds and lateral one-third by falling on the outstretched hand. Nutrient artery is commonly originated from the artery which participates in the early invasion of the ossifying bone, in such a manner that the nutrient foramen is found at the actual center of ossification (8).

So, the nutrient artery is particularly vital during the active growth period and at the early phases of ossification. The position of the nutrient foramen and the direction of the nutrient canal in mammalian bones are variable and may alter during growth. Though there are variations in positions, number, and direction of nutrient foramina in clavicles there are limited studies on it in Bangladesh. This study aimed to determine the morphological and morphometric variations of neurovascular foramina of adult human clavicles in Bangladesh.

Methods

This cross-sectional descriptive study was conducted in the Department of Anatomy, Rajshahi Medical College over one year from January 2022 to December 2022. This study was performed on dry adult human clavicle bones which were collected from the students of the Department of Anatomy of Rajshahi Medical College as well as from the different Medical Colleges of Bangladesh after fulfilling the inclusion criteria. Howev-

er, damaged bones, malformed bones, and bones with congenital anomalies were excluded from the study. A total of 350 clavicles were included in the study by purposive sampling technique. Data were collected by a semi-structured questionnaire and the sex of clavicles was determined by observation of different sex determination variables. The number and position of nutrient foramen were determined by observation and their direction was measured by a guide wire and 24-hypodermic needle (0.56 mm in diameter). Independent samples t-test was used to determine the relationship of the position and number of neurovascular foramina between the right and left side and between the male and female adult human clavicles. A p-value less than 0.05 was found statistically significant for all tests.

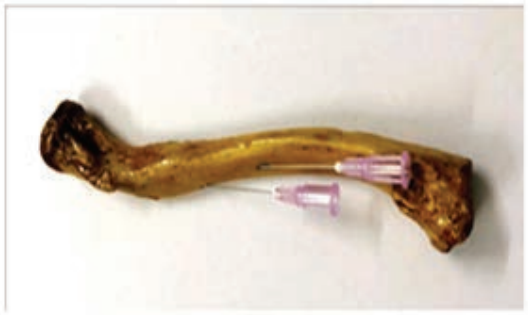


Fig 1: Double nutrient foramina.

Fig 2: Triple nutrient foramina.

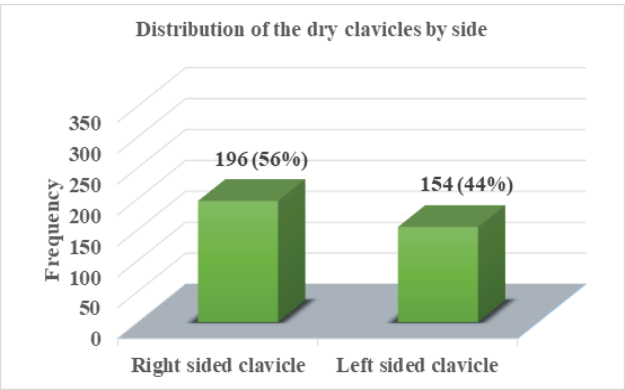
Fig 3: Nutrient foramina at the inferior surface.

Fig 4: Nutrient foramen at the posterior surface.

Results

Out of 350 dry adult clavicles, 196 (56%) were from the right side and 154 (44%) were from the left side (Figure I).

Figure I: Distribution of the dry clavicles according to side (n=350).



The position of the nutrient foramina of the clavicles revealed that 359 (80.70%) of the nutrient foramina were on the posterior surface, 79 (17.80%) on the inferior surface, 5 (1.10%) on the superior surface and 2 (0.40%) on the anterior surface (Table 1).

Table 1: Position of the nutrient foramina on the surface of clavicles (number of nutrient foramina=445).

Positions of the nutrient foramina	Frequency	Percentage
Posterior surface	359	80.70%
Inferior surface	79	17.80%
Superior surface	5	1.10%
Anterior surface	2	0.40%
Total	445	100%

Number of the nutrient foramina of the clavicles revealed that 251 (71.70%) clavicles contained single nutrient foramen, 85 (24.30%) double, 8 (2.30%) triple foramina and 6 (1.70%) were none (Table 2).

Table 2: Number of the nutrient foramina of the clavicles (n=350).

Number of the nutrient foramina	Frequency	Percentage
None	6	1.70%
Single nutrient foramen	251	71.70%
Double nutrient foramina	85	24.30%
Triple nutrient foramina	8	2.30%
Total	350	100%

All the nutrient foramina were directed toward the acromial end, and none was directed toward the sternal end of the dry adult human clavicles (Table 3).

Table 3: Direction of the nutrient foramen of the clavicles (number of nutrient foramina=445).

Direction of nutrient foramen	Frequency	Percentage
Acromial end	445	100%
Sternal end	0	0%
Total	445	100%

The difference in position of the neurovascular foramina between the right & left-sided adult human clavicles was found statistically non-significant ($p > 0.05$).

Table 4: Relationship of the position of the neurovascular foramina between the right & left-sided adult human clavicles (number of nutrient foramina=445).

Position of nutrient foramina	Right	Left	Total
	Frequency (%)		
Posterior surface	198 (55.15%)	161 (44.85%)	359 (80.70%)
Inferior surface	47 (59.49%)	32 (40.51%)	79 (17.80%)
Superior surface	3 (60%)	2 (40%)	5 (1.10%)
Anterior surface	1 (50%)	1 (50%)	2 (0.40%)
Total	249 (55.96%)	196 (44.04%)	445 (100.00%)

$\chi 2=0.56$, df=3, $p > 0.05$

The difference in the number of neurovascular foramina between the right & left-sided adult human clavicles was not statistically significant ($p > 0.05$).

Table 5: Relationship of the number of neurovascular foramina between the right & left-sided adult human clavicles (n=350).

Number	Right	Left	Total
	Frequency (%)		
None	2 (33.30%)	4 (66.70%)	6 (1.70%)
Single foramen	142 (56.60%)	109 (43.40%)	251 (71.70%)
Double foramina	49 (57.60%)	36 (42.40%)	85 (24.30%)
Triple foramina		5 (62.50%)	8 (2.30%)
Total	196 (56%)	154 (44%)	350 (100.00%)

The difference in position of the neurovascular foramina between the right & left-sided adult human clavicles was found statistically non-significant ($p > 0.05$).

Table 6: Relationship of the position of the neurovascular foramina between the male & female adult human clavicles (number of nutrient foramina=445).

Position of nutrient foramina	Male	Female	Total
	Frequency (%)		
Posterior surface	228 (63.50%)	131 (36.50%)	359 (80.70%)
Inferior surface	50 (63.29%)	29 (36.71%)	79 (17.80%)
Superior surface	4 (80.00%)	1 (20.00%)	5 (1.10%)
Anterior surface	2 (100.00%)	0 (0%)	2 (0.40%)
Total	284 (63.82%)	161 (36.18%)	445 (100.00%)

$\chi 2=1.73$, df=3, $p > 0.05$

The difference in number of the neurovascular foramina between the male & female adult human clavicles was not statistically significant ($p > 0.05$).

Table 7: Relationship of the number of neurovascular foramina between the male & female adult human clavicles (n=350).

Number	Male	Female	Total
	Frequency (%)		
None	3 (50.00%)	3 (50.00%)	6 (1.70%)
Single foramen	165 (65.70%)	86 (34.30%)	251 (71.70%)
Double foramina	52 (61.20%)	33 (38.80%)	85 (24.30%)
Triple foramina	5 (62.50%)	3 (37.50%)	8 (2.30%)
Total	225 (64.30%)	125 (35.70%)	350 (100.00%)

$\chi 2=1.12$, df=3, $p > 0.05$

Discussion

The clavicle is an atypical long bone characterized by many unique embryologic features. It is the first bone to ossify and its most part is intramembranous in origin. The clavicle possesses larger or smaller foramina (openings) for the entrance of blood vessels and nerves. The objective of this study was to assess the morphological and morphometric variations of neurovascular foramina of adult human clavicles in Bangladesh.

This study revealed that among 350 dry adult clavicles, 225 (64.30%) were male and 125 (35.70%) were female. In the distribution of the sides of the clavicles, 196 (56%) were from the right side and 154 (44%) were from the left side.

The position of nutrient foramina on the surface of clavicles showed by the present study that 359 (80.70%) of the nutrient foramina were on the posterior surface, 79 (17.80%) on the inferior surface, 5 (1.10%) on the superior surface and 2 (0.40%) on the anterior surface of the clavicles. Studies done by Tanna (3), Kumar et al. (9), Sowmiya and Sundarapandian (10), Sahu and Meher (11), and Joshi and Mathu (12) showed similar findings. Murlimanju et al. (1) where the foramen was found on the inferior surface of 29 (55.8%) clavicles, on the posterior surface of 36 (69.2%), and on the superior surface only 1 (1.9%) which was not consistent with this study.

In the present study, 251 (71.70%) clavicles showed single nutrient foramen, 85 (24.30%) double and 8 (2.30%) triple. On 6 (1.70%) clavicles no nutrient foramen was found. Nearly similar findings were seen in a research done by Keche et al. (13) where out of 67 clavicles, 44 (65.67%) showed single foramen and 22 (32.84 %) double. The study done by Joshi and Mathur (12) where out of 50 clavicles, 34 (68%) presented a single foramen and 16 (32%) double foramina which was consistent with the current study.

Furthermore, a study done by Murlimanju et al. (1) in India showed that the neurovascular foramina were observed in 50 (96.1%) clavicles and absent in 2 (3.9%). Single foramen was seen in 20 (38.5%) clavicles, double in 23 (44.2%), and triple in 7 (13.4%). Rai et al. (5), Tanna and Tanna (3), and Sahu and Meher (11)

reported that nutrient foramina were present in all of their study clavicles but the present study revealed that the nutrient foramina were found in 344 (98.30%) clavicles. Rai et al. (5), Tanna and Tanna (3), and Sahu and Meher (11) also observed that double foramina were found in more than 50% of clavicles which was nearly similar to this study.

Moreover, clavicles are supplied by the periosteal vessels when there is an absence of nutrient foramina (7) and the periosteal vessels become the sole source of blood supply where the nutrient foramen was absent.

All nutrient foramina were directed towards the acromial end, and none was directed to the sternal end of the dry adult human clavicles revealed by the present study. These findings were in accordance with the study done by Keche et al. (13) where all the nutrient foramina were directed towards the acromial end. Murlimanju et al. (1) showed that in 48 (96%) clavicles, the foramina were directed toward the acromial end, and in 2 (4%) clavicles, the foramina were directed towards the sternal end which was nearly similar to this study. Similar findings were also found in the studies done by several researchers (Rai et al. (5), Tanna and Tanna (3), Sahu et al. (11), Joshi and Mathur (12), Fischer and Carret (14), Havet et al. (15) and Kumar et al. (16)). Sowmiya and Sundarapandian (10) and Rekha et al. (17) found 4.8% and 4.79% of nutrient foramina directed towards the sternal end respectively which were not similar with the present study.

The middle third region of the clavicle is most involved in any type of injury and accounts for 5–10% of all fractures in adults. Havet et al. (15) described the arterial supply of the clavicle to clarify the pathological mechanism and the surgical procedure of non-unions. The periosteal vessel was always present on the superior surface and anterior border of the clavicle but never on the inferior surface or posterior border. The periosteal vessels located between the muscular insertions could be compromised in case of displacements or fractures.

So, the relationship of the position of the neurovascular foramina between the right & left-sided adult human clavicles was found statistically not-significant ($p > 0.05$). Keche et al. (13) also reported similar findings where the position of nutrient foramina on the surfaces of both sides was found statistically not significant ($p > 0.05$).

So, the relationship of the number of neurovascular foramina between the right & left-sided adult human clavicles was not statistically significant ($p > 0.05$). Similar findings were reported by Keche et al. (13) where the number of nutrient foramina on both sides was found statistically not significant ($p > 0.05$).

The information about the position, number, and direction of nutrient foramina is useful for surgeons performing surgical procedures like internal fixation, coracoclavicular ligament repair, transplant techniques, and bone grafting. The clinical knowledge of the nutrient foramina and its variations is important, as microvascular bone transfer is becoming more popular.

Conclusion

The clinical knowledge of the nutrient foramina and its variations are important, as microvascular bone transfer is becoming more popular where preservation of the circulation of the affected bone is of vital importance for facilitating graft healing in the recipient.

Limitations of the study

Limitations were data were collected from 6 medical colleges, a purposive sampling technique was selected and the sample size was only 350 which was small.

References

1. Murlimanju BV, Prabhu LV, Pai MM, Yadav A, Dhananjaya KVN, Prashanth KU. Neurovascular foramina of the human clavicle and their clinical significance. Surg Radiol Anat. 2011; 33 (8): 679–682.

2. Champatyray S, Nayak SR, Mishra T. Study of Neurovascular Foramina of the Human Clavicle and Their Clinical Significance. Annals of the Romanian

Society for Cell Biology. 2012; 25 (4): 14534-14541.

3. Tanna N, Tanna V. Anatomical variation in position, direction, and number of nutrient foramina in clavicles. Int J Med Sci Public Health. 2015; 4 (3): 357.

4. Standring, S.ed., 2016. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 41st ed. London: Elsevier.

5. Rai R, Shrestha S, Kavitha B. Morphological and topographical anatomy of nutrient foramina in human clavicles and their clinical importance. IOSR-JDMS. 2014; 13 (1): 37-40.

6. Patel HG, Babariya D, Pensi CA. Nutrient foramina of dry human clavicle and their clinical significance. IJSR. 2014; 3 (11): 324-325.

7. Knudsen FW, Andersen M, Krag C. The arterial supply of the clavicle. Surg Radiol Anat. 1989; 11 (3): 211–214.

8. Malukar O, Joshi H. Diaphysial nutrient foramina in long bones and miniature long bones. Lateral. 2011; 2 (2): 23-26.

9. Kumar D, Raichandani L, K Kataria S, Singh J. Variation in number and position of nutrient foramen of clavicle – A morphological study in western Rajasthan. IJASHNB. 2019; 5 (3): 67–71.

10. Sowmiya G, Sundarapandian S. Neurovascular foramina of the human clavicle and their clinical significance. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016; 7 (6): 2634-2640.

11. Sahu S, Meher D. Morphological and topographical anatomy of nutrient foramina in human clavicles of Eastern Odisha. International Journal of Applied Research. 2017; 3 (4): 521-523.

12. Joshi P, Mathur S. A comprehensive study of nutrient foramina in human lower limb long bones of the Indian population in Rajasthan state. … Journal of Health Sciences and Research. 2018; 3 (3): 36-42.

13. Keche HA, Thute PP, Fulmali DG, Keche AS. Morphometric study of nutrient foramina in dry human clavicles in central India. jemds. 2021;10 (28): 2099–2103.

14. Fischer LP, Carret JP. [Arterial vascularization of human bones]. Bull Assoc Anat (Nancy). 1978; 62 (179): 419–452.

15. Havet E, Duparc F, Tobenas-Dujardin AC. Vascular anatomical basis of clavicular non-union. Surgical and Radiological Anatomy. 2008; 30 (1): 23-28.

16. Kumar R, Madewell JE, Swischuk LE, Lindell MM, David R. The clavicle: normal and abnormal. Radiographics. 1989; 9 (4): 677–706.

17. Rekha S. Morphometric study of nutrient foramen in dry human clavicle bones of Jammu Region. International Journal of Research and Analytical Reviews. 2019; 6 (1): 413x-416x.