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ORIGINAL RESEARCH

Assessment of variations in number, position and direction of nutrient foramina of clavicle

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ABSTRACT
Background: Human beings are bestowed with the power of bipedal locomotion; the clavicle serves as a strut that permits the upper limb to freely move away from the chest wall. The present study was conducted to assess variations in the number, position, and direction of nutrient foramina in the clavicle
Materials & Methods: 54 dried adult human clavicles were taken. The foraminal distance from the sternal end (DNF) and the total length of the clavicle (TL) were measured. The foramen index (FI): FI = (DNF/TL) ×100, DNF = distance of nutrient foramen from the proximal end (sternal end) of the clavicle, TL = total length of clavicle, was calculated.
Results: Out of 54 bones, 30 were males and 24 were females. The number of nutrient foramen was 1 in 42, 2 in 8, and 3 in 4 clavicles. The position of the nutrient foramen was anterior in 14 cases and posterior in 40 cases. Location was anterior one-third in 19 and middle one-third in 35 cases. The direction was towards the acromial end in 54 cases. The difference was significant ($P < 0.05$). The mean total length of the clavicle was 140.3 mm. The mean distance of foramina from the sternal end (DNF) was 64.1 mm. The mean foramen index (FI) was 45.3.
Conclusion: Orthopaedic surgeons and radiotherapists treating clavicular pathologies need to be aware of morphometric information regarding the nutrient foramen and its variations.
Key words: Clavicle, nutrient foramen, morphometric

Introduction

Human beings are bestowed with the power of bipedal locomotion; the clavicle serves as a strut that permits the upper limb to freely move away from the chest wall.[1] As structures, bones adjust to their mechanical environment and, from an early age, to the existence of holes that occur in the natural world. Blood vessels can travel through the bone cortex thanks to these openings, also known as nutrient foramina. [2] A subclavian groove is visible on the clavicle's inferior surface. At the lateral end of the groove that runs laterally, there is a nutrient foramen. A tiny foramen was reported to be possible along the superior border of the middle third of the clavicle.[3] This artery conveys nutrients through this foramen. His foramen transmits the medial fascicle of the supraclavicular nerve. Anatomically, it was described that this foramen was present in 2–6% of the population.[4] The main blood supply to a long bone is provided by the nutrient artery, which is crucial during the early stages of ossification and the embryo's and foetus's active growth periods.[5] The largest foramen on long bones, the nutrient foramen, is where the nutrient artery for that particular bone travels. A modified long bone called the clavicle is positioned subcutaneously and horizontally at the base of the neck. It also transfers upper limb weight to the axial skeleton.[6] A subclavian groove is visible on the clavicle's inferior surface. At the lateral end of the groove that runs laterally, there is a nutrient foramen.[7]

Aims and objectives: The present study was conducted to assess variations in the number, position, and direction of nutrient foramina in the clavicle.

Materials and Methods

The present cross-sectional study consisted of 54 dried adult human clavicles bones, 27 on the right side and 27 on the left side, of a human whose age and sex were unknown, in the department of anatomy from different regions of Bihar, India (Jannayak Karpoori Thakur Medical College and Hospital, Madhepura; Jawaharlal Nehru Medical College, Bhagalpur; and Sri Krishna Medical College and Hospital, Muzaffarpur). Ethical clearance was obtained before starting the study. The duration of the study was from October 2021 to August 2023. In this study, the number, location, direction, and distance of nutrient foramina from two ends were observed. Variations observed during the study were photographed, and the data collected were analysed and compared with the literature. The nutrient foramina were detected with a magnifying glass by the presence of a well-marked groove and slightly raised margin at the commencement of the canal. The direction of the canal was measured. The foraminal distance from the sternal end (DNF) and the total length of the clavicle (TL) were measured using a Vernier calliper.

The Hughes formula was used for calculating the foramen index (FI): FI = (DNF/TL) ×100,

where DNF is the distance of the nutrient foramen from the proximal end (sternal end) of the clavicle and TL is the total length of the clavicle.

Statistical analysis: The results thus obtained were subjected to statistical analysis using SPSS version 22.0 (IBM Corp., 2016). A statistical analysis was performed on the obtained data. Text, tables, charts, and other graphics were used to present the data. Continuous data were expressed as the mean and standard deviation, whereas qualitative data were expressed as percentages. A P value less than 0.05 were considered significant.

Results

Table I: Side wise distribution of bones

Total clavicles bones (n = 54)		
clavicle	**Right side**	**Left side**
Number	27	27

Table I shows that out of 54 bones, 30 were on the right side and 24 were on the left side.

Table II: Assessment of parameters

Parameters	Variable	Right clavicle (n=27)	Left clavicle (n=27)	Total (n=54),%	P value
Number of nutrient foramen	1	19	23	42 (77.78%)	0.02
	2	5	3	8(14.81%)	
	3	3	1	4(7.41%)	
Position	Anterior surface	1	-	1(1.85%)	0.01
	Posterior surface	19	17	36 (66.67%)	
	Superior surface	-	1	11(1.85%)	
	Inferior surface	7	9	16 (29.63%)	
Location	Medial one- third	4	5	9 (16.67%)	0.03
	Middle one- third	20	17	37 (68.52%)	
	Lateral one-third	3	5	8 (14.81%)	
Direction	towards the acromial end	23	19	42 (77.78%)	-
	towards the sternal end	4	8	12 (22.22%)	-

Table II, shows that the number of nutrient foramen was 1 in 42 (77.78%), 2 in 8 (14.81%), and 3 in 4 (7.41%) clavicles. The position of the nutrient foramen was 1 (1.85%) on each anterior and superior surface, whereas the posterior surface was in 36 (66.67%) and the inferior surface was in 16 (29.63%) of clavicles, respectively. Location was medial one-third in 9 (16.67%), middle one-third in 37 (68.52%), and lateral one-third in 8 (14.81%) of clavicles, respectively. The direction was towards the acromial end in 42 (77.78%) and towards the sternal end in 12 (22.22%) of the clavicles, respectively. The difference was significant (P< 0.05).

Table III: Assessment of measurement

Parameters	Mean	SD
Mean TL (mm)	140.3	1.5
Mean DNF (mm)	64.1	2.4
Mean FI (%)	45.3	1.1

Table III, graph 1, shows that the mean total length of the clavicle was 140.3 mm. The mean distance of foramina from the sternal end (DNF) was 64.1 mm. The mean foramen index (FI) was 45.3.

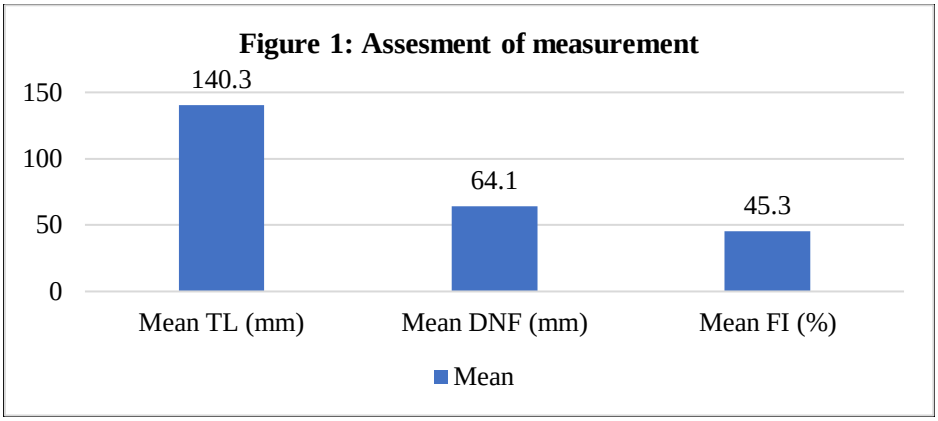

Table IV: Comparison of different studies on the number of nutrient Foramen In Dry Human Clavicles

Researcher	Year of study	Number Of bones	Number of nutrient foramen in bones		
			One	Two	Three
Sahu and Meher[15]	2017	100	43.38	50.93	5.65 %
Ratnesh et al.[16]	2018	*60*	65	26.66	8.33
Kumar et al[13]	2019	102	75.49	14.71	1.96
Sinha et al.[17]	2020	50	70	24	6
Dakshayani and Shivanal[18]	2021	100	80	17	0
Present study	2023	54	77.78%	14.81%	7.41%

Figure 2: Position of nutrient foramen in dry human clavicles

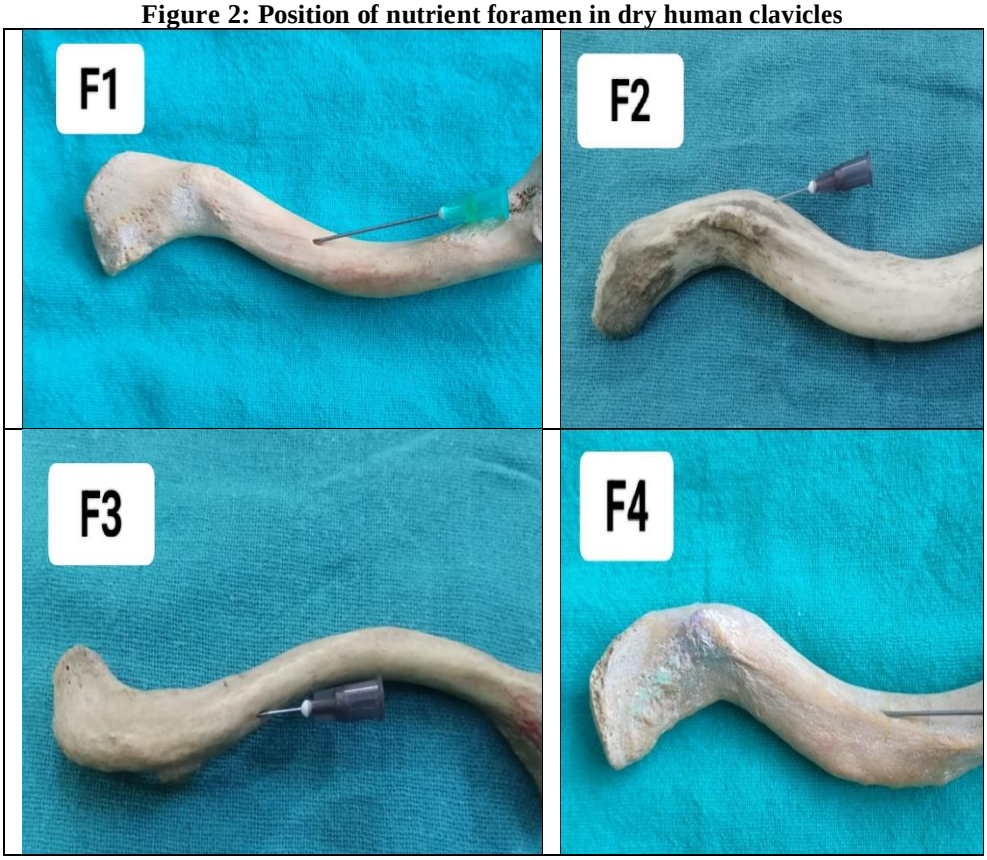

Figure showing the location of the nutrient foramen in dry human clavicles:
F1: Right Clavicle with a single nutrient foramen on the inferior surface in the middle, one third
F2: Right Clavicle with single nutrient foramen on the inferior surface in lateral one third
F3:Right Clavicle with single nutrient foramen on posterior surface in lateral one third
F4: Right Clavicle with a single nutrient foramen on the posterior surface in the middle third

Discussion

The clavicle, a modified long bone, is positioned across the neck's root horizontally.[8] The arm is kept away from the trunk by the clavicle.[9,10] The most frequently fractured bone in the body is the clavicle. The point where the middle and outer thirds of the clavicle converge is its weakest point. When someone falls on their outstretched hand, this is where fractures most frequently occur. This is also where the nutrient foramen is located.[11,12] The present study was conducted to assess variations in the number, position, and direction of nutrient foramina in the clavicle. We found that out of 54 bones, 27 were on the right side and 27 were on the left side. The number of nutrient foramen was 1 in 42, 2 in 8, and 3 in 4 clavicles. Kumar et al.[13] studied 102 adult clavicles, 52 on the right side and 52 on the left side. All the bones were grossly observed for the number, location, and direction of the nutrient foramina. Nutrient foramina were present in 50 clavicles (right) and 44 clavicles (left). Out of which are single foramina in 41 clavicles (right) and 36 clavicles (left), double foramina in 9 clavicles (right) and 6 clavicles (left), and three foramina in 2 clavicles (left). The absence of nutrient foramina was found in 2 clavicles (right) and 8 clavicles (left). The maximum number was present in the medial 2/3 and on the posterior surface of 46 bones (right) and 34 bones (left). All foramina were directed towards the acromial end. We observed that the position of the nutrient foramen was anterior in 14 cases and posterior in 40 cases. Location was anterior one-third in 19 and middle one-third in 35 cases. The direction was towards the acromial end in 54 cases. The mean total length of the clavicle was 140.3 mm. The mean distance of foramina from the sternal end (DNF) was 64.1 mm. The mean foramen index (FI) was 45.3. Aggarwal et al.[14] studied 79 dry adult human clavicles (40 right, 39 left), and the mean foramen index (FI) was calculated. The mean length of the clavicles studied was 141.36 ± 11.11 mm (right 140.51 ± 11.10 mm, left 142.36 ± 11.14 mm). The average distance of foramina (DNF) from the sternal end was 61.48 ± 15.82 mm (right 62.88 ± 16.28 mm, left 59.96 ± 15.12 mm). A nutrient foramen was found in all the studied bones. The total foramina observed are 120. Forty-four bones have single (55.70%), 29 double (36.71%), and 6 triple (7.59%) foramina. Foramina were distributed on all four surfaces of the clavicle, predominantly on the posterior surface (52.50%). Most foramina were present in the middle third (67.50%) with an average FI% of 43.82 ± 11.85 (right 44.99 ± 12.09, left 42.43 ± 11.41). The foramina were directed toward the acromial end in all cases.

Limitations of the study: small sample size and short duration of study.

Conclusion

The authors found that orthopaedic surgeons and radiotherapists treating clavicular pathologies need to be aware of morphometric information regarding the nutrient foramen and its variations.

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