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Original Research Article

Morphometric Study of Nutrient Foramen of Clavicle in Maharashtrian Population

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Abstract

Background: The clavicle, a specialized long bone situated horizontally at the base of the neck, plays a crucial role in providing support and facilitating the free movement of the upper limb. This study aims to explore the variability in the position, direction, and number of nutrient foramina in the clavicle and assess their clinical significance.

Methods: A total of 100 dried human clavicles were examined, with 50 specimens each for the right and left clavicles. The age and gender of the specimens were not identified. Specimens with damage, deformities, or significant pathological abnormalities were excluded. Nutrient foramina were observed for number, position, location, and orientation. The Hughes formula was utilized to calculate the foramen index.

Results: In every clavicle, at least one nutrient foramen was identified. The distribution included 70% with a single foramen, 24% with two, and 6% with three. The posterior surface was the predominant location (55.88%), followed by the inferior surface (41.17%) and the superior surface (2.94%). The middle one-third of the clavicle exhibited the highest concentration of nutrient foramina (70.58%). The average distance from the sternal end was 69.63 mm, resulting in a foramen index of 52.25.

Discussion: Our findings align with previous studies, emphasizing the variability in nutrient foramen distribution. Notably, the posterior surface predominance corresponds with existing literature. The study provides valuable insights for surgical procedures such as internal fixation and vascularized bone grafting, emphasizing the importance of preserving arterial supply.

Conclusion: This investigation sheds light on the distinctive characteristics of nutrient foramina in the clavicle. The knowledge gained can enhance surgical precision and outcomes in procedures involving the clavicle.

Keywords: Clavicle, Nutrient foramen, Foramen index, Surgical procedures, Arterial supply.

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Introduction

The clavicle is a curved, specialized long bone positioned horizontally at the base of the neck. Its primary function is to provide support, allowing the upper limb to move freely away from the trunk [1,2]. Additionally, it plays a role in transmitting the weight of the upper limb to the axial skeleton. The clavicle consists of a cylindrical shaft with two ends: the sternal (medial) end and the acromial (lateral) end. The clavicle's shaft is segmented into a lateral one-third and a medial two-thirds [3,4]. The lateral portion is flattened, featuring superior and inferior surfaces, as well as anterior and posterior borders. In contrast, the medial two-thirds of the shaft is cylindrical and exhibits four surfaces: anterior, posterior, superior, and inferior [4,5]. The lower surface of the clavicle's shaft contains a subclavian groove, and typically, the nutrient foramen is situated to the side of this groove, with a lateral orientation. The nutrient artery supplying the clavicle is derived from the suprascapular artery. Every long bone, including the clavicle, features a nutrient foramen through which the nutrient artery passes [5,6]. This artery serves as the primary source of blood supply to the long bone during its period of active growth. The nutrient foramen in all bones is oriented away from the growing end, a correlation first noted by Berard [7]. Lutken [8] further emphasized that the variable position of the nutrient

foramen and its determination can be achieved through a thorough examination of human bones. Understanding the position, direction, and quantity of nutrient foramina is crucial in surgical and orthopedic interventions, such as the internal fixation of the clavicle and vascularized bone grafting [9,10]. Preserving arterial supply is essential for the effective repair of fractures and the survival of osteocytes and osteoblasts. The primary goal of this research was to assess the variability in the position, direction, and number of nutrient foramina in the clavicle and explore their clinical significance.

Material and Methods

The investigation involved the examination of 100 dried human clavicles from Maharashtrian cadavers (comprising 50 right and 50 left specimens) within the Anatomy department. The age and gender of the bones were not identified.

Specimens with any form of damage, deformity, or significant pathological abnormalities were excluded from the study. The focus of the examination on all clavicles included the assessment of nutrient foramina in terms of their number, position, location, and orientation.

The Hughes[11] formula was employed to compute the foramen index.

FI = (DS/TL) X 100

FI- Foramen index

DS- Distance of nutrient foramen from the sternal end of clavicle

TL- Total length of the clavicle (Ignoring curves of the clavicle)

All observations were documented using: a) Magnifying lens b) Hypodermic needle with a diameter of 0.56mm (0.24 gauge) c) Digital vernier caliper

Result

In every examined clavicle, a nutrient foramen was identified. Among the clavicles, 70% had a single nutrient foramen, 24% exhibited two, and 6% displayed three. Specifically, 64% of right clavicles and 76% of left clavicles featured a singular nutrient foramen. Additionally, two nutrient foramina were observed in 28% of right clavicles and 20% of left clavicles, while three nutrient foramina were present in 8% of right clavicles and 4% of left clavicles. The total count of observed nutrient foramina across all specimens was 136.

Table 1: illustrates the quantity of nutrient foramina observed in the clavicle.

Number of nutrient foramen	Right(25)	Left(25)	Total(50)
1	16 (64.0%)	19 (76.0%)	35 (70.0%)
2	7 (28.0%)	5 (20.0%)	12 (24.0%)
3	2 (8.0%)	1 (4.0%)	3 (6.0%)

The nutrient foramen was located on the posterior surface in 55.88% of cases, the inferior surface in 41.17%, and the superior surface in 2.94%. In right clavicles, 61.11% exhibited the nutrient foramen on the posterior surface, 38.88% on the inferior surface, and none on the superior surface. Meanwhile, in left clavicles, 50% had the nutrient foramen on the posterior surface, 43.75% on the inferior surface, and 6.25% on the superior surface.

Table 2: Displays the placement of nutrient foramina in the clavicle.

Surface	Right	Left	Total
Posterior	22 (61.11%)	16 (50.0%)	38 (55.88%)
Inferior	14 (38.88%)	14 (43.75%)	28 (41.17%)
Superior	0	2 (6.25%)	2 (2.94%)

In terms of location, the nutrient foramen was distributed as follows: 10.29% in the medial 1/3rd region, 70.58% in the middle 1/3rd, and 19.11% in the lateral 1/3rd of the clavicle. Specifically for the right clavicle, 8.33% of nutrient foramina were situated in the medial 1/3rd, 72.22% in the middle 1/3rd, and 19.44% in the lateral 1/3rd. For the left clavicle, 12.50% were in the medial 1/3rd, 68.75% in the middle 1/3rd, and 18.75% in the lateral 1/3rd.

Table 3: Illustrates the situation of nutrient foramina in the clavicle.

Region of clavicle	Right	Left	Total
Medial 1/3rd	3 (8.33%)	4 (12.50%)	7 (10.29%)
Middle 1/3rd	26 (72.22%)	22 (68.75%)	48 (70.58%)
Lateral 1/3rd	7 (19.44%)	6 (18.75%)	13 (19.11%)

The average distance of the nutrient foramina from the sternal end was measured at 69.63 mm, while the average total length of the clavicle was 133.26 mm. Consequently, the foramen index was calculated to be 52.25. Importantly, the direction of all nutrient foramina was observed to be away from the sternal end.

Table 4: provides information on the Foramen Index (FI).

DS (in mm)	TL (in mm)	FI
69.63	133.26	52.25

Table 5: demonstrates a comparison in reference to existing literature.

PARAMETERS	Malukar et al.	Rahul Rai et al.	Ruchi Ratnesh et al.	Present study
Number of foramina				
1	68%	42.50%	65%	70%
2	21%	52.50%	26.66%	24%
>2	10%	5%	8.33%	6%
Position				
Superior	1.40%	--	1.66%	2.94%
Inferior	42.50%	35.40%	72.90%	41.17%
Posterior	56.30%	64.60%	26.74%	55.88%
Location				
Medial1/3rd	8.40%	15.40%	11.66%	10.29%
Middle1/3rd	59.10%	73.80%	66.66%	70.58%
Lateral1/3rd	32.30%	10.80%	21.66%	19.11%
Direction of nutrient foramen	Towards acromial end	Towards acromial end	Towards acromial end	Towards acromial end

Discussion

In our current investigation, it was determined that 70% of clavicles featured a single nutrient foramen, 24% had two foramina, and 6% exhibited three nutrient foramina. This distribution closely aligns with findings from studies conducted by Malukar et al. [12] and Ruchi Ratnesh et al. [13] However, in a separate study conducted by Rahul Rai et al. [14], the prevalence of one nutrient foramen was 42.5%, two foramina were found in 52.5%, and three foramina were present in 5% of clavicles.

In our research, the nutrient foramen was predominantly situated on the posterior surface (55.88%), aligning closely with findings from studies conducted by Malukar et al (56.3%) and Rahul Rai et al. [14] (64.6%). In contrast, a study by Ruchi Ratnesh [13] et al reported a predominant position of the nutrient foramen on the inferior surface (72.9%).

Furthermore, our study revealed that the highest concentration of nutrient foramina occurred in the middle one-third of the clavicle (70.58%), a result consistent with the observations made by Rahul Rai et al. [14] (73.8%).

In our investigation, we determined that the average distance of the nutrient foramen from the sternal end was 69.63 mm, with a foramen index of 52.25. These findings closely parallel those from studies conducted by Rahul Rai et al. [14], where the average distance was reported as 67.6 mm and the foramen index as 48.01. Similarly, Santosh K Sahu et al. [15] observed an average distance of 65.8 mm from the sternal end and a foramen index of 52.06.

Conclusion

Based on our investigation, it can be inferred that the clavicle typically features a predominant nutrient foramen, primarily located on the posterior surface. The highest concentration of nutrient foramina was observed in the middle one-third of the clavicle, followed by the lateral one-third and then the medial one-third in terms of bone length. Additionally, our study revealed that the direction of the nutrient foramen tends to be toward the acromial end.

Understanding the nutrient foramen patterns in the clavicle holds practical significance, especially in surgical procedures such as internal fixation and vascularized bone grafting, where preserving arterial supply is crucial for successful outcomes.

Limitations

The study's limitations include a relatively small and region-specific sample size of 100 Maharashtrian clavicles, lacking consideration for demographic factors such as age and gender. The findings may not be universally applicable, and broader ethnic and geographical variations were not explored. Additionally, details about the preservation methods were not provided, impacting the study's ability to account for potential alterations in morphometric

features. Consideration of these limitations is crucial for a comprehensive understanding of the study's scope and generalizability.

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