



ORIGINAL ARTICLE

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Number, Position, and Direction of Clavicular Nutrient Foramina: An Anatomical Variation Study

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ABS TRAC T

Background: Anatomical variation in nutrient foramina can affect interpretation of bone anatomy and has implications for surgical approaches. This study presents a structured description of number, position, and direction of nutrient foramina in the clavicle.

Methods: The supplied study examined 100 dried human clavicles. Nutrient foramina were identified and categorized according to number, surface, longitudinal location, and direction. Morphometric parameters were also recorded.

Results: Single, double, and triple foramina occurred in 70%, 24%, and 6% of specimens, respectively. Posterior, inferior, and superior surface frequencies were 55.88%, 41.17%, and 2.94%. Medial, middle, and lateral third frequencies were 10.29%, 70.58%, and 19.11%. Mean distance from the sternal end was 69.63 mm and foramen index was 52.25.

Conclusion: The findings confirm that nutrient foramina are variable in number and position but show a predominant pattern of one foramen, posterior surface placement, and middle-third location.

Keywords: Nutrient foramen; clavicle; anatomical variation; nutrient canal; morphometry.

INTRODUCTION

Anatomical variation is a central concept in osteology because structures that are described as typical may not be present in every specimen in an identical form. Nutrient foramina illustrate this principle clearly.

The clavicle is particularly interesting because it is a horizontally positioned long bone with changing morphology along its length. The source article describes a shaft with different surface configurations and a subclavian groove on the inferior aspect.

Nutrient foramina permit passage of vessels to the bone. Their number may be one, two, or more, and their position may be posterior, inferior, or occasionally superior. Their longitudinal position may also vary.

Understanding this variation is important in clinical anatomy. Clavicular surgery may require manipulation

of the bone and surrounding tissues, and knowledge of vascular entry points can support preservation of local blood supply.

The source study identified at least one nutrient foramen in every examined clavicle. However, the number was not uniform. Most specimens had one, while a smaller proportion had two or three.

Surface and regional distribution also demonstrated variation. The posterior surface was dominant, but the inferior surface accounted for a substantial proportion. The middle third clearly predominated along the length.

The present related manuscript organizes these findings as an anatomical variation study and compares them with the literature cited in the source.

AIM AND OBJECTIVES

Aim: To describe the variation in number, surface position, longitudinal location, and direction of nutrient foramina in human clavicles.

- To determine the frequency of one, two, and three nutrient foramina.
- To document posterior, inferior, and superior surface distribution.
- To document medial, middle, and lateral third distribution.
- To assess nutrient canal direction.
- To summarize the morphometric position of the foramen.

MATERIALS AND METHODS

Study Design

The investigation was a descriptive observational anatomical study based on direct examination of dried human clavicles. The approach was intended to characterize nutrient foramina according to number, surface position, longitudinal location, direction, and selected morphometric parameters.

Study Material

The uploaded study reports examination of 100 dried human clavicles from Maharashtrian cadaveric material in an Anatomy Department. The age and sex of the specimens were not identified. The source describes the collection as including right and left clavicles.

Selection of Specimens

Clavicles showing damage, deformity, or significant pathological abnormality were excluded. The purpose was to examine apparently suitable specimens without gross changes that could interfere with identification of the nutrient foramen.

Anatomical Parameters

Each specimen was inspected for the number of nutrient foramina, the surface on which the foramen was located, its position within the medial, middle, or lateral one-third, and the direction of the nutrient canal. The distance of the foramen from the sternal end and the total clavicular length were also considered.

Instruments and Measurement

The source study documented use of a magnifying lens, a hypodermic needle with a reported diameter of 0.56 mm, and a digital vernier caliper. The curved clavicle was measured according to the protocol described in the source, with the total length used in the foramen-index calculation.

Foramen Index

The Hughes formula was used: $FI = (DS/TL) \times 100$. DS represents the distance of the nutrient foramen from the sternal end, while TL represents the total clavicular length.

Data Presentation

The results are presented descriptively using frequencies, percentages, and the reported mean morphometric values. No additional statistical analysis has been added because the uploaded source does not provide raw individual-level measurements or the statistical framework needed for further analysis.

RESULTS

A nutrient foramen was reported in every examined clavicle. The overall pattern showed a predominance of a single nutrient foramen, with smaller proportions demonstrating two or three foramina. The source article reports a total of 136 nutrient foramina across the examined material.

Table 1. Number of nutrient foramina

Number of foramina	Percentage
1	70.0%
2	24.0%
3	6.0%

The surface distribution demonstrated a posterior predominance. The posterior surface accounted for 55.88% of reported foramina, followed by the inferior surface at 41.17% and the superior surface at 2.94%.

Table 2. Surface distribution of nutrient foramina

Surface	Percentage
Posterior	55.88%
Inferior	41.17%
Superior	2.94%

Longitudinally, the middle one-third was the principal region containing nutrient foramina. The lateral one-third was the second most frequent region, while the medial one-third showed the lowest proportion.

Table 3. Longitudinal distribution

Region	Percentage
Medial 1/3rd	10.29%
Middle 1/3rd	70.58%
Lateral 1/3rd	19.11%

Table 4. Reported morphometric values

Parameter	Reported value
Distance from sternal end	69.63 mm
Total clavicle length	133.26 mm
Foramen Index	52.25
Direction	Toward acromial end

Analysis of Anatomical Variation

The number of nutrient foramina showed the greatest variation at the level of multiplicity. A single foramen occurred in 70%, indicating a dominant pattern, but 30% of specimens had more than one. Therefore, the presence of a second or third foramen should be recognized as a normal anatomical possibility rather than automatically interpreted as abnormal.

The posterior surface was the most common location. Nevertheless, 41.17% of the reported foramina were on the inferior surface. This substantial proportion makes it inappropriate to assume that all nutrient foramina will be posterior.

Superior-surface foramina were uncommon at 2.94%. The rarity of this location makes it a notable anatomical variation within the supplied material.

Longitudinally, the middle third was dominant at 70.58%. The medial and lateral thirds accounted for smaller proportions. This pattern indicates regional concentration rather than uniform distribution.

The direction toward the acromial end was reported consistently. Direction is an important part of nutrient canal anatomy because it provides information about the orientation of the vascular channel.

Table 5. Variation profile

Variable	Observed pattern
Foramen number	1: 70%; 2: 24%; 3: 6%
Most common surface	Posterior (55.88%)
Second surface	Inferior (41.17%)
Least common surface	Superior (2.94%)
Most common region	Middle 1/3rd (70.58%)
Direction	Toward acromial end
Foramen index	52.25

DISCUSSION

The present findings illustrate that anatomical variation can be quantified. The 70% frequency of one foramen is similar to several studies cited in the source article, while the study by Rahul Rai et al. showed a markedly higher proportion of two foramina.

Surface differences between studies are also evident. The source comparison reports posterior predominance in Malukar et al. and Rahul Rai et al., whereas Ruchi Ratnesh et al. reported a strong inferior predominance. This variation may arise from population characteristics, sampling differences, or methodological differences.

The middle-third predominance is more consistent across the cited studies. The source table reports middle-third values of 59.1%, 73.8%, and 66.66% in the three comparison studies, compared with 70.58% in the present source.

The foramen index offers an additional method for describing position relative to bone length. The reported value of 52.25 can be compared with the 48.01 reported by Rahul Rai et al. and 52.06 reported by Sahu et al., as discussed in the source article.

From an anatomical perspective, these findings emphasize that a standard description should be treated as a predominant pattern rather than an absolute rule.

Clinical Relevance

Recognition of normal anatomical variation is relevant during clavicular surgery, internal fixation, and vascularized grafting. The findings support preservation of vascular structures and avoidance of unnecessary soft-tissue disruption. They may also help trainees understand why a nutrient foramen may not always appear in the same location on every clavicle.

Limitations

The material is region-specific and lacks demographic information. No individual-level dataset is available in the source, so relationships between foramen characteristics and age, sex, or other variables cannot be assessed. The source manuscript should also be checked for internal sample-count consistency before submission.

CONCLUSION

Nutrient foramina of the clavicle exhibit meaningful variation in number and location. The dominant pattern in the supplied data was a single foramen on the posterior surface within the middle one-third, with canals directed toward the acromial end. The variation should be considered in anatomical teaching and clinical procedures.

Financial Support and Sponsorship

The uploaded source article reports that no financial support or sponsorship was received.

Conflict of Interest

The uploaded source article reports no conflict of interest.

Ethical/Specimen Note

This manuscript is based on the anatomical observations reported in the supplied source. The source does not provide a detailed institutional ethics statement or cadaver-donation protocol in the supplied text; therefore, no additional ethics claim has been introduced here.

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