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Clinical Anatomical Considerations of Clavicular Nutrient Foramina in Fracture Fixation and Bone Grafting

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ABS TRAC T

Background: The vascular anatomy of the clavicle is important in fracture healing and reconstructive surgery. Nutrient foramina represent pathways for nutrient vessels and may be vulnerable during operative manipulation. This related manuscript examines the supplied anatomical findings from a clinical anatomy perspective.

Methods: One hundred dried human clavicles were examined for nutrient foramen number, surface location, longitudinal distribution, direction, and morphometric position. The reported observations were interpreted in relation to internal fixation and vascularized bone grafting.

Results: One nutrient foramen occurred in 70% of specimens, two in 24%, and three in 6%. The posterior surface was the dominant site (55.88%), and the middle one-third was the dominant region (70.58%). Mean distance from the sternal end was 69.63 mm, total clavicular length was 133.26 mm, and foramen index was 52.25. The canals were directed toward the acromial end.

Conclusion: The findings demonstrate clinically relevant variation in nutrient foramen anatomy. Awareness of the dominant pattern and individual variability may support careful surgical handling of the clavicle.

Keywords: *Clavicle; fracture fixation; nutrient artery; nutrient foramen; vascularized bone graft; surgical anatomy.*

INTRODUCTION

The clavicle is a key component of the shoulder girdle and functions both as a structural strut and as a pathway for transmission of upper-limb forces to the axial skeleton. Its position and shape expose it to mechanical stress and make it a frequent focus of orthopedic evaluation.

Bone healing depends on adequate vascularity. Nutrient arteries contribute to the blood supply of bone, and the nutrient foramen provides a route for these vessels. Although the periosteal and other vascular networks also contribute to bone blood supply, nutrient foramina remain important anatomical landmarks.

Operative fixation of clavicular fractures involves exposure and manipulation of the bone. Knowledge of nutrient foramen location may help surgeons understand where nutrient vascular structures may enter the cortex.
Vascularized bone grafting is another context in which preservation of vascular structures is important. The source article specifically identifies internal fixation and vascularized bone grafting as clinically relevant applications of nutrient foramen knowledge.

The supplied study showed that most foramina were located in the middle one-third and on the posterior surface. These findings provide an anatomical basis for heightened awareness of this region.

However, the presence of substantial inferior-surface distribution and multiple foramina demonstrates that the dominant pattern cannot be treated as universal. Individual anatomy may differ.

This related manuscript therefore discusses the findings in a clinical anatomical framework without claiming that the supplied cadaveric observations directly measure surgical outcomes.

AIM

To interpret the anatomical distribution of clavicular nutrient foramina in relation to fracture fixation and reconstructive procedures.

OBJECTIVES

- To summarize the number and location of nutrient foramina.
- To identify the most common surface and longitudinal region.
- To report the morphometric location and foramen index.
- To explain potential clinical relevance to clavicular surgery.
- To identify limitations in translating cadaveric findings directly to clinical practice.

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) × 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

Clinical Interpretation of Results

The predominance of a single nutrient foramen indicates that one principal nutrient entry point is common in the supplied material, although nearly one-third of specimens had two or three. Therefore, surgeons should not assume that a clavicle has only one nutrient opening.

The posterior surface was the most frequent site at 55.88%. The inferior surface was also common at 41.17%. These two surfaces together accounted for almost all reported foramina, while superior-surface placement was uncommon.

The middle one-third contained 70.58% of the reported foramina. Because this region is important in clavicular fracture management, the finding provides a useful anatomical consideration during exposure and fixation.

The mean distance of 69.63 mm from the sternal end and the foramen index of 52.25 provide quantitative landmarks. These values describe the source sample and should not be used as fixed measurements for every patient.

The direction toward the acromial end is another consistent feature in the supplied observations. Understanding direction may assist in conceptualizing the course of nutrient canals through the cortex.

Implications for Fracture Fixation

The findings suggest that operative handling of the clavicular shaft should respect the possibility of nutrient vascular entry, particularly in the middle third and posterior region. Avoidance of unnecessary stripping and careful soft-tissue handling are reasonable anatomical principles. The present study does not provide clinical outcome data and therefore cannot establish that preservation of a particular foramen improves union rates.

Implications for Vascularized Bone Grafting

The nutrient foramen is relevant to understanding the vascular architecture of bone. When vascularized bone is planned, identification and preservation of appropriate vascular structures are important. The present anatomical observations can contribute to background planning but do not identify a specific operative vascular pedicle.

Implications for Anatomy Education

The study offers an accessible example of how anatomical variation can influence clinical reasoning. Students can use the data to understand that the clavicle has a dominant nutrient foramen pattern but that multiple openings and different surface locations are possible.

Comparison with Literature

Table 5. Selected source comparison

Parameter	**Malukar**	**Rahul Rai**	**Ruchi Ratnesh**	**Present source**
Single	68%	42.5%	65%	70%
Two	21%	52.5%	26.66%	24%
Posterior	56.3%	64.6%	26.74%	55.88%
Inferior	42.5%	35.4%	72.9%	41.17%
Middle 1/3rd	59.1%	73.8%	66.66%	70.58%

DISCUSSION

The source literature demonstrates that the exact surface distribution of nutrient foramina varies. This is important clinically because it argues against relying on a single universal surface landmark.

The middle-third concentration is more consistent across the compared studies. The present value of 70.58% falls within the general pattern reported by the cited studies.

The source article reports a foramen index of 52.25, close to the values discussed from Rahul Rai et al. and Sahu et al. This suggests that the relative location of the nutrient foramen may be more consistent than some surface-level differences.

Clinical interpretation should remain cautious. Dried bone studies describe anatomy but cannot reproduce living vascular flow, soft-tissue relationships, or patient-specific surgical conditions.

Nevertheless, the observations provide useful baseline information for understanding why preservation of the vascular environment around the clavicle is relevant.

Limitations

The study is anatomical rather than clinical and therefore does not establish relationships between nutrient foramen preservation and fracture union, infection, implant failure, or other outcomes. The sample is regional and lacks age and sex information. The source also has an internal sample/table denominator issue requiring verification.

CONCLUSION

The nutrient foramen pattern of the clavicle has potential clinical relevance to fixation and reconstructive procedures. The supplied data demonstrate predominant posterior and middle-third placement, a mean sternal-end distance of 69.63 mm, and a foramen index of 52.25. These findings support anatomical awareness while recognizing individual variation.

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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