

Glob. J. Med. Pharm. Sci.
ISSN PRINT: 2957-3610, **ISSN ONLINE**: 2957-3629
Website: https://globapc.com/
Open Access Journal

Global
Journal of Medical and
Pharmaceutical Sciences

ORIGINAL ARTICLE **OPEN ACCESS**

Morphometric Analysis of Nutrient Foramina of the Human Clavicle: Number, Position, and Foramen Index

Dr. P D Sonje[1], Dr. N S Kanasker[2]
[1]Assistant Professor, Department of Anatomy Dr. D. Y. Patil Medical College, Maharashtra, India
[2]Professor, Department of Anatomy Dr. D. Y. Patil Medical College, Maharashtra, India

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Corresponding Author
Dr. N S Kanasker
Professor, Department of Anatomy Dr. D. Y. Patil Medical College, Maharashtra, India

Received:11-01-2025
Accepted:15-02-2025
Available online:25-02-2025

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ABS TRAC T

Background: The clavicle possesses a distinctive vascular anatomy that is relevant to growth, fracture healing, internal fixation, and reconstructive procedures. Nutrient foramina are important anatomical landmarks because they provide channels for nutrient vessels. Their number and location vary among clavicles and populations. This related manuscript focuses on the morphometric characteristics of clavicular nutrient foramina.
Materials and Methods: One hundred dried human clavicles from Maharashtrian cadaveric material were examined. Specimens with damage, deformity, or significant pathological abnormality were excluded. Nutrient foramina were recorded according to number, surface, longitudinal region, and direction. The distance from the sternal end and total clavicular length were measured, and the Hughes foramen index was calculated.
Results: A single nutrient foramen was reported in 70% of specimens, two in 24%, and three in 6%. The posterior surface was the most frequent site (55.88%), while the middle one-third was the most common longitudinal location (70.58%). The mean distance from the sternal end was 69.63 mm, mean total clavicle length was 133.26 mm, and the foramen index was 52.25. The canals were directed toward the acromial end.
Conclusion: The study demonstrates a reproducible descriptive pattern of nutrient foramina with a predominance of a single foramen, posterior-surface location, and middle-third distribution. The reported morphometric values provide useful anatomical reference data.

Keywords: *Clavicle; nutrient foramen; morphometry; foramen index; nutrient artery; anatomical variation.*

INTRODUCTION

The clavicle is a specialized long bone located horizontally at the base of the neck. It contributes to the architecture of the shoulder girdle, supports the upper limb, and transmits forces between the upper extremity and axial skeleton. Its unusual shape and orientation distinguish it from many other long bones.

The clavicle consists of a sternal end, an acromial end, and an intervening shaft. The medial portion is relatively cylindrical, whereas the lateral portion becomes flatter. The inferior aspect contains the subclavian groove, and the arrangement of surfaces changes along the shaft.

Nutrient foramina are openings through which nutrient vessels gain access to bone. The nutrient artery contributes to osseous vascularity and is therefore relevant to bone maintenance and repair. The position and direction of the nutrient canal are not identical in all bones or all specimens.

The direction of a nutrient canal has traditionally been related to the growth pattern of a bone. The uploaded study reports that all identified nutrient foramina were directed away from the sternal end and toward the acromial end.

Anatomical variation in nutrient foramina has practical significance. Clavicular fractures are common clinical problems, and operative treatment may require exposure of the shaft and placement of fixation devices. Understanding the vascular anatomy can help surgeons avoid unnecessary disruption of structures associated with bone blood supply.

Previous studies have demonstrated differences in the number and location of clavicular nutrient foramina.

Some reports show a predominance of one foramen, whereas others report a greater frequency of two foramina. Surface distribution also varies, with posterior and inferior locations both described.

The present manuscript therefore emphasizes the morphometric dimension of the supplied anatomical observations, while retaining the reported findings and terminology of the source study.

AIM AND OBJECTIVES

Aim: To describe the morphometric and anatomical characteristics of nutrient foramina in the human clavicle.

- To document the number of nutrient foramina per clavicle.
- To determine the predominant surface location.
- To assess the longitudinal distribution across the clavicle.
- To document the direction of nutrient canals.
- To report the distance from the sternal end and total clavicular length.
- To calculate and interpret the foramen index.
- To discuss the relevance of these measurements to clinical anatomy.

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

Detailed Interpretation of the Findings

The numerical distribution indicates that the majority of clavicles had a single nutrient foramen. The 70% frequency of a single foramen was higher than the proportions for two or three foramina. This indicates that although multiple foramina occur, a single identifiable nutrient opening represents the dominant pattern in the supplied material.

The surface data showed a posterior predominance. More than half of the reported foramina were situated on the posterior surface. The inferior surface accounted for a substantial additional proportion, while the superior surface was uncommon.

The longitudinal data were particularly notable because more than two-thirds of the reported foramina were located in the middle one-third. The lateral one-third contained a smaller proportion and the medial one-third the least. This concentration gives the middle shaft special anatomical importance.

The morphometric values provide a quantitative complement to the descriptive findings. The reported mean distance from the sternal end was 69.63 mm and the mean total clavicular length was 133.26 mm. Using the stated formula, the source reports a foramen index of 52.25.

The direction of the nutrient canals toward the acromial end was uniform in the supplied observations. This direction is consistent with the general anatomical concept of nutrient canal orientation away from the growing end.

Taken together, the findings demonstrate that clavicular nutrient foramina are variable but not randomly distributed. A dominant pattern can be described, while individual variation must still be expected.

Comparison with Previous Literature

Table 5. Selected comparison reported in the source article

Parameter	Malukar et al.	Rahul Rai et al.	Ruchi Ratnesh et al.	Present source
1 foramen	68%	42.50%	65%	70%
2 foramina	21%	52.50%	26.66%	24%
>2	10%	5%	8.33%	6%
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%
Middle 1/3rd	59.10%	73.80%	66.66%	70.58%

Clinical Significance

The quantitative position of a nutrient foramen may be useful in understanding areas where vascular entry occurs. During surgical exposure of the clavicle, preservation of local soft-tissue and vascular structures is an important anatomical consideration.

The middle-third predominance is relevant because this region is frequently discussed in relation to clavicular fractures and operative fixation. The finding does not establish a surgical contraindication, but it emphasizes the need for awareness of local anatomy.

For vascularized bone grafting and reconstructive procedures, knowledge of nutrient vessel entry points can be useful in planning. The present study provides descriptive anatomical information rather than direct operative outcome data.

These observations can also serve as teaching material for anatomy students and surgical trainees because they demonstrate how surface anatomy, longitudinal location, and quantitative measurements can be integrated.

Limitations

The source study is limited by a region-specific sample, lack of age and sex information, and absence of individual-level raw measurements. The supplied article also contains an internal denominator inconsistency between its stated sample description and some table entries. This issue should be reconciled against the original laboratory records before formal submission.

CONCLUSION

The clavicle demonstrates measurable variation in nutrient foramen number and position. In the supplied material, one nutrient foramen was the predominant pattern, the posterior surface was the most frequent surface, and the middle one-third was the most common longitudinal region. The reported mean distance from the sternal end was 69.63 mm and the foramen index was 52.25. These data contribute to the anatomical understanding of clavicular vascular entry points.

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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