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

Morphological and Topographical Characteristics of Clavicular Nutrient Foramina: Comparative Anatomical Perspective

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OPEN ACCESS

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Received:11-11-2024
Accepted:18-12-2024
Available online:28-12-2024

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ABS TRAC T

Background: Nutrient foramina of the clavicle show variation in number, position, and direction. Comparative assessment of these features can help place regional anatomical observations within the wider literature. This manuscript provides a detailed comparative perspective using the observations reported in the supplied study.
Methods: The source study examined 100 dried clavicles and recorded nutrient foramen number, surface, longitudinal location, direction, and morphometric position. The present related manuscript summarizes those findings and compares them with the studies cited by the source.
Results: One foramen was reported in 70%, two in 24%, and three in 6%. Posterior, inferior, and superior surface distributions were 55.88%, 41.17%, and 2.94%, respectively. Medial, middle, and lateral third distributions 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: Comparative evidence shows a broadly recurring middle-third concentration and acromial direction, while surface distribution varies among studies. The present data contribute to the anatomical literature on clavicular nutrient foramina.

Keywords: *Clavicle; comparative anatomy; nutrient foramen; morphometry; population variation; anatomical study.*

INTRODUCTION

Comparative anatomy is useful for determining which anatomical characteristics appear relatively stable and which vary among populations or study samples. Nutrient foramina provide an appropriate model because their number and location can be described objectively on dry bones.

The clavicle has a distinctive morphology and is clinically important. Its nutrient foramina provide pathways for vessels entering the bone, and their distribution may be relevant to surgical procedures.

The supplied study was performed on Maharashtrian cadaveric clavicles. The authors compared their observations with studies by Malukar et al., Rahul Rai et al., Ruchi Ratnesh et al., and Sahu et al.

One notable feature of the literature is variation in the reported number of foramina. Some studies show a predominance of one, while Rahul Rai et al. reported two foramina more frequently.

Surface distribution is also variable. The present source and Malukar/Rahul Rai studies show posterior predominance, whereas Ruchi Ratnesh et al. reported inferior predominance.

Longitudinal distribution appears more consistent, with the middle third generally showing the highest proportion. The present source reports 70.58%, similar to values in several cited studies.

The purpose of this related manuscript is therefore to present a detailed comparative analysis without introducing new numerical data beyond the supplied study.

AIM

To provide a comparative anatomical assessment of

nutrient foramina of the clavicle using the findings reported in the supplied study and its cited literature.

OBJECTIVES

- To summarize the main numerical findings of the supplied study.
- To compare the number of foramina across selected studies.
- To compare surface distribution across studies.
- To compare longitudinal distribution across studies.
- To compare morphometric findings and direction of nutrient canals.
- To discuss possible reasons for differences without making unsupported causal claims.

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

Comparative Results

Table 5. Comparison of number of nutrient foramina

Number	Malukar et al.	Rahul Rai et al.	Ruchi Ratnesh et al.	Present source
1	68%	42.50%	65%	70%

2	21%	52.50%	26.66%	24%
>2	10%	5%	8.33%	6%

Table 6. Comparison of surface position

Surface	Malukar et al.	Rahul Rai et al.	Ruchi Ratnesh et al.	Present source
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%

Table 7. Comparison of longitudinal location

Region	Malukar et al.	Rahul Rai et al.	Ruchi Ratnesh et al.	Present source
Medial 1/3rd	8.40%	15.40%	11.66%	10.29%
Middle 1/3rd	59.10%	73.80%	66.66%	70.58%
Lateral 1/3rd	32.30%	10.80%	21.66%	19.11%

DISCUSSION

The comparative table shows that the present source had the highest reported proportion of one nutrient foramen among the four listed studies, although the difference from Malukar et al. and Ruchi Ratnesh et al. was relatively modest.

The Rahul Rai study differed substantially in the number category, reporting 52.5% with two foramina and 42.5% with one. This demonstrates that multiplicity may vary considerably between samples.

For surface location, the present posterior value of 55.88% was close to Malukar et al. at 56.3% and lower than Rahul Rai et al. at 64.6%. In contrast, Ruchi Ratnesh et al. reported a much lower posterior value and a high inferior value.

The middle-third pattern was comparatively stable: 59.1%, 73.8%, 66.66%, and 70.58% across the four studies. This recurring concentration suggests that the middle third is an important region for further anatomical investigation.

The source article also reports that the nutrient canals were directed toward the acromial end, matching the direction reported in the comparison studies.

Possible explanations for inter-study differences include population characteristics, specimen selection, sample size, methods of identifying foramina, and classification procedures. These possibilities are interpretive considerations rather than conclusions directly tested by the supplied dataset.

Comparative anatomy should therefore distinguish between recurring patterns and population-specific findings. The present study adds evidence supporting a middle-third concentration while demonstrating substantial surface and multiplicity variation.

Morphometric Comparison

Table 8. Morphometric values reported in the supplied study

Parameter	Present source
Mean distance from sternal end	69.63 mm
Mean total clavicle length	133.26 mm
Foramen index	52.25
Direction	Toward acromial end

The source discussion compares its morphometric values with previous observations. It reports a mean distance of 67.6 mm and foramen index of 48.01 from Rahul Rai et al., and a mean distance of 65.8 mm and foramen index of 52.06 from Sahu et al. These comparisons suggest broadly similar relative positioning, although direct statistical comparison cannot be performed without complete raw datasets.

Clinical and Anatomical Relevance

The comparative evidence is useful for anatomy because it shows that the nutrient foramen should be described as a variable structure rather than a fixed landmark.

For surgery, the recurring middle-third concentration is relevant, but the differences in surface distribution indicate that individual variation should be anticipated.
For education, presenting several studies side by side helps trainees appreciate both the dominant anatomical pattern and the limits of generalized descriptions.

For future research, larger studies with standardized measurement protocols, known demographic variables, and individual-level data would permit more rigorous comparison.

Limitations

The comparative analysis is limited by the information available in the supplied source and its cited studies. Not all studies provide identical methodological details or sample characteristics. No new raw data were available for independent statistical comparison. The source article also contains a discrepancy between its stated specimen numbers and some table denominators, which should be resolved.

CONCLUSION

Comparative evidence indicates substantial variation in the number and surface location of clavicular nutrient foramina, while a middle-third concentration and acromial direction recur across studies. The present source contributes a foramen index of 52.25 and a mean sternal-end distance of 69.63 mm. These findings reinforce the value of population-specific anatomical studies and careful clinical interpretation.

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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