ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 12 | December - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ANATOMICAL VARIATIONS IN THE NUTRIENT FORAMEN OF CLAVICLE AND ITS CLINICAL SIGNIFICANCE

Anatomy

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ABSTRACT

Introduction: The nutrient foramen of clavicle is most commonly present in middle 1/3rd of the shaft on its inferior surface at the lateral end of the subclavian groove with many variations. A detailed anatomy of its nutrient foramen is important for clinicians and surgeons to make accurate diagnosis, effective treatment of clavicular fracture and its precise surgical planning, leading to improved outcomes. **Aims And Objectives:** The aim is to explore to its number, location, direction, distance of foramen from the sternal end in relation to the distance of the clavicle (between medial end and the lateral end) by measuring foramen index and its clinical importance. **Material And Methods:** 70 dried intact clavicles were taken from the Department of Anatomy, B.R.D. Medical College, Gorakhpur and measured using digital vernier calliper. **Results:** Single foramen was found in 40% of samples, while two, three, and four foramina were present in 30%, 17.14%, and 10%, respectively. Clavicles with a maximum of six foramina were observed in 2.86% of cases. Most foramina (60.96%) were located on the posterior surface, with 33.56% on the inferior, 4.11% on the anterior, and 1.37% on the superior surfaces. Additionally, 80.82% were found in the middle third, and 94.52% of the foramina directed towards the acromial end. **Conclusion:** The variations of nutrient foramen in the clavicle influence surgical approaches and interventions in clavicular injuries and transplant procedures for improving the outcome of procedures where vascularized bone grafting is required.

KEYWORDS

INTRODUCTION

Clavicle is the only long bone lying horizontally at the root of the neck. It is a crank-shaped cantilever that carries scapula, so enabling the limb to swing clear to the trunk. Lateral end is flat, articulates with the medical border of acromian process in the scapula to form acromio-clavicular joint. While the medical end is quadrangular, articulates with the clavicular notch of manubrium sterni and also with the first costal cartilage to form the sternoclavicular joint.

The shaft is curved resembling italic f, being convex forward in its medial 2/3rd part and concave forwards in its lateral 1/3rd part. Medial 2/3rd part is likely quadrangular having 4 surfaces viz. anterior, superior, posterior and inferior whereas the lateral part is more likely flat having 2 surfaces: superior & inferior; 2 borders: anterior & posterior. The medial 1/3rd part has a subclavian groove on its inferior surface for the insertion of subclavius muscles.

The nutrient foramen is present at the lateral end of the subclavian groove for the passage of the nutrient artery in the middle third of the clavicle but its precise location can vary between individuals. Variations may include multiple foramina or an atypical position, reflecting differences in vascular supply among populations.

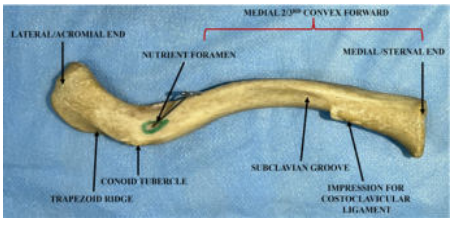


Figure 1- Right Side Clavicle (inferior Surface)

The foramina direct the nutrient artery towards the medullary cavity, ensuring adequate nourishment to the bone. Nutrient artery arises from the suprascapular artery, but may also arise from the clavicular branch of thoraco-acromial artery and rarely from a branch of internal thoracic artery.

Clinically, understanding the anatomy of the nutrient foramen is vital during surgical procedures involving the clavicle as it is one of the most common bone to fracture. Improper handling of this area during fracture fixation and joint reconstruction can lead to complications like avascular necrosis or delayed healing due to disrupted blood supply and may sometimes cause non-union. Also, the knowledge of the nutrient foramen's variations can aid radiologists and surgeons in interpreting imaging studies accurately, ensuring better surgical outcomes and enhanced patient care. Thus, being significant for both understanding clavicular physiology and improving clinical practices.

Aim And Objectives

The aim of this study is to explore the nutrient foramen in the clavicle under the following parameters:

1. Number of foramina,
2. Location of foramen,
3. Direction of foramen,
4. Distance of foramen from the sternal end: In relation to the distance of the clavicle (between medial end and the lateral end) by measuring foramen index and its clinical importance.

MATERIAL AND METHODS

70 dried intact clavicles were taken from the Department of Anatomy, B.R.D. Medical College, Gorakhpur. Clavicle were cleaned and observed for the presence of nutrient foramen.

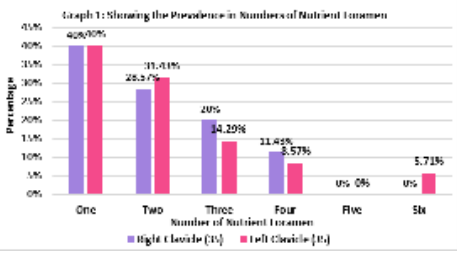
The number and location of nutrient foramen were noted by observing the clavicle thoroughly and noted as medial 1/3rd, middle 1/ 3rd and lateral 1/3rd. Direction of the nutrient foramen was identified by placing pins in the nutrient foramen. And the distance from the sternal end was measured using digital vernier calliper with an accuracy of 0.03mm. Foramen Index was calculated using the Hughes formula

Foramen Index = (DNF/TL) × 100

DNF= Distance of Nutrient Foramen from the Sternal/Medial end

TL= Total length of the Clavicle

OBSERVATION AND RESULTS

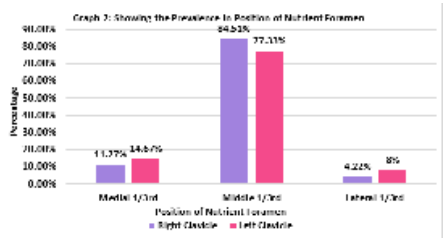


The right clavicle, 14 samples had 1 foramen (40%), 10 had 2 foramen (28.57%), 7 had 3 foramen (20%), and 4 had 4 foramen (11.43%). No samples had 5 or 6 foramina, out of 35.

The left clavicle, 14 samples also had 1 foramen (40%), 11 had 2 foramen (31.43%), 5 had 3 foramen (14.29%), and 3 had 4 foramen (8.57%). Two samples had 6 foramen (5.71%), out of 35 samples.

FIGURE 2- RIGHT SIDE CLAVICLE (INFERIOR SURFACE)

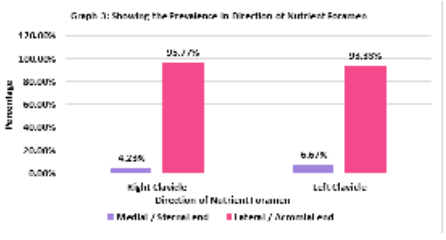
FIGURE 3- LEFT SIDE CLAVICLE (INFERIOR SURFACE)



For the right clavicle, the distribution of foramen showed that 8 (11.27%) were located in the medial third, 60 (84.51%) in the middle third, and 3 (4.22%) in the lateral third, totaling 71 foramina.

In the left clavicle, 11 (14.67%) were found in the medial third, 58 (77.33%) in the middle third, and 6 (8%) in the lateral third, with a total of 75 foramen.

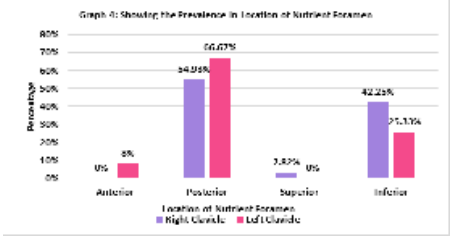
P-value was found to be 0.496823 using Z-test.



In the right clavicle, the direction of the nutrient foramen was predominantly lateral, with 68 occurrences (95.77%), while 3 (4.23%) were directed medially out of 71 foramina.

For the left clavicle, 70 foramen (93.33%) were also directed laterally, and 5 (6.67%) medially, out of 75 foramina.

P-value was found to be 0.517081



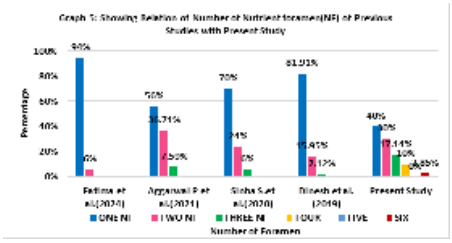
For the right clavicle, there were no foramen on the anterior surface, 39 on the posterior (54.93%), 2 on the superior (2.82%), and 30 on the inferior (42.25%), out of 71.

For the left clavicle, there were 6 on the anterior (8%), 50 on the posterior (66.67%), none on the superior, and 19 on the inferior (25.33%), out of 75.

P Value was found to be 0.0083 using Z-test.

The mean foramen index was found to be 49.53 on the right side and 50.95 on the left side.

DISCUSSION



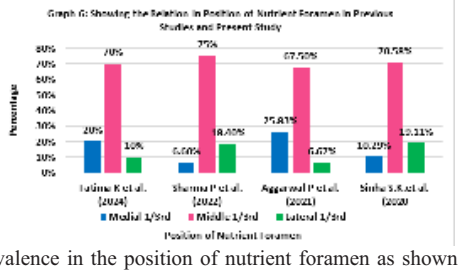
The prevalence in the number of nutrient foramen as seen in the Graph 5 across different studies shows similarity with that of the present study with a decreasing trend of prevalence in number of nutrient foramen.

Single foramina found in 94%, 56%, 70%, 81.91% from the studies of Fatima K et al., Aggrawal P et al., Sinha S et al. and Dinesh K et al. respectively including our study with 40% single NF but lower rates for subsequent categories.

Whereas in the present study 4 foramina was found in 10% of the cases and 6 foramina in 2.85% of the total cases which is not in accordance with previous studies.

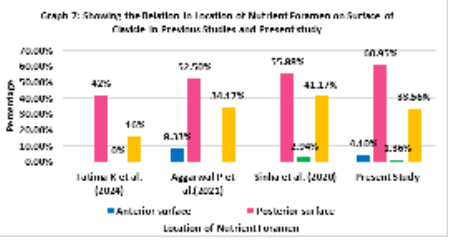
These variations may arise from differences in sample size, demographics, and methodologies.

Understanding these factors is vital for developing targeted interventions and improving patient management strategies in future research.



The prevalence in the position of nutrient foramen as shown in the Graph 6 was 70%, 75%, 67.5%, &0.58% from the studies of Fatima K et al., Sharma P et al., Aggrawal P et al., and Sinha S.K. et al. which was in accordance with the present study showing 80.82% from the total.

Whereas 20% and 25.83% from the studies of Fatima K et al. and Aggrawal P et al. were present in medial 1/3rd of clavicle showing similarity with the present study with prevalence of 13.01%. But the studies of Sharma P et al. and Sinha S.K. were not in accordance with present study.

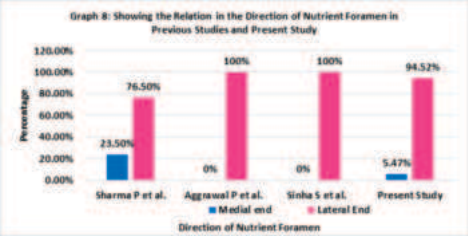


The Graph 7 shows that the location of nutrient foramen on the clavicle was mostly on the posterior surface than the inferior surface across different studies with prevalence of 42%, 52.5% and 55.88% from the studies of Fatima K et al., Aggrawal P et al. and Sinha S. K. et al. in accordance with the present study showing 60.95% of the total cases.

Whereas in the present study 4.10% of the total foramina were found

on the anterior surface and 1.36% on the superior surface.

The data across these studies suggest a strong emphasis on posterior surface.



Graph 8 shows that majority of foramina were directed towards the towards the acromial end across different studies with prevalence of 76.50% from the study of Fatima Ket al. and 100% from both Aggrawal P et al. & Sinha S. K. et al. showing similarity with the present study.

CONCLUSION

The anatomical variations of nutrient foramina in the clavicle are important for both development and clinical practice.

These foramina are crucial for the vascular supply to the bone, impacting its health and healing process.

Variations in their location, number, and size can affect blood flow during surgeries, making it essential for surgeons to understand them for preventing complications like avascular necrosis.

As research unveils the complexity of clavicular anatomy, it emphasizes the need for individualized orthopedic care.

Ultimately, this knowledge enhances surgical techniques, improves patient outcomes, and informs decisions in surgical planning and post-operative management.

Conflict of Interest: The authors declare no conflicts of interest.
Funding: No funding was received.
Consent: Written consent from participants has been obtained and preserved.
Ethical Approval: Ethical approval was obtained and documented as per institutional guidelines.

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