

Anatomical Variations of Nutrient Foramina in Dry Adult Human Clavicles: Morphological and Morphometrical Research

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ABSTRACT

Introduction: Clavicle is S shape modified long bone placed horizontally in the body. Nutrient artery is the principal source of the blood to a long bone, it enters the bone shaft through the nutrient foramen, predominantly during its growth period in the embryo, as well as during the early phases of ossification during childhood. Vascularized bone and joint allograft survival depend strongly on the blood supply of that bone.

Aims and objectives: Estimated the number, location, direction, and distance of nutrient foramina from two ends, and were observed, photographed, and analyzed.

Materials and methods: In this study, 100 clavicle bones were observed, 50 on the right side and 50 on the left side of unknown age and sex. The clavicle bones were obtained from the department of anatomy in a tertiary care medical institute in Punjab.

Results: In this study, nutrient foramina were present in all clavicles (100%), out of which single foramina in 33 clavicles of right (66%) and 46 clavicles of left (92%), double foramina in 11 clavicles of the right (22%) and 3 clavicles of the left (6%), and three foramina in 1 clavicle of left (2%) and 6 clavicles of right (12%). Foramina directed toward the acromial end were 76.5% and toward the sternal end were 23.5%. Mostly nutrient foramina were present on middle one-third of the shaft (75%) and predominantly seen on the posterior surface (68.4%).

Conclusion: Nutrient foramen plays a crucial role in surgical, and orthopedical procedures such as bone grafting and bone transplantation, and is useful to safeguard arterial circulation during radiation treatment given during carcinoma in the neck.

Keywords: Clavicle, Nutrient artery, Nutrient foramina.

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INTRODUCTION

Human bodies are granted with the command of bipedal motion and the clavicle bone perform its function as a support to permit the free movement of the joints of the upper limb aside from the thoracic wall.¹ The clavicle bone is an adapted long bone which is kept transversally in the body and hypodermically at the origin of the neck. The clavicle conveys the weight of body from upper limb to the skeleton.² The name of clavicle bone comes from two words, that is, CLAVIS (a key) and ICLE (diminutive). It is also known as a collarbone and is denoted as a beauty bone due to its prominent shape in the body of females. It is more curved and broader in males than in females.³

A nutrient foramen is a customary hole in the bones, usually in the diaphysis, which provides a way for the blood vessels into the medullary cavity present in every bone and provides development and nourishment to it.⁴ Blood supply to a long bone is provided by its nutrient artery, which enters the bone shaft from the nutrient foramen, predominantly while its development period in the fetus, as well as in the initial stages of bone formation during childhood.⁵ The nutrient artery is a branch of the supraclavicular or clavicular branch of thoracoacromial artery.^{6,7} However, the nutrient foramina present in the clavicle bones are clinically significant as these in order to overhaul the fractures in clavicle bones, which harvests observable complications such as injuries in brachial plexus and entrapment syndromes of supraclavicular nerves. Mostly, the clavicular bone fractures heal with good efficient results following inoperative treatment is no longer required.⁸ The acquaintance of

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nutrient foramen is significant in clinical measures like microsurgical vascularized bone transplantation and graft procedures of bones. As these methods are becoming widespread, knowledge concerned with the morphological depiction of these openings is useful to reserve the circulation of the affected bony parts. It is also helpful to the orthopedists for surgeries such as bone transplantation and bone grafting where blood supply is vital and should be conserved to promote fracture repair.⁹ The Nutrient blood supply is extremely significant in the procedures like vascular bone grafting and must be conserved to encourage repair of fractures, a respectable quality of arterial supply is necessary for survival of osteocyte and osteoblast cell survival, as well as to help the healing of graft in the receiver.^{10,11} Topographical knowledge is very useful to conserve arterial supply during radiation therapy.¹² Knowledge of these variations

in the nutrient foramina, help in placing internal fixation device in fractures of the clavicle.¹³ Our study provides extra information and awareness of the topography of nutrient foramina, which will be useful in surgeries such as microsurgical repairs of displaced, malunited, or comminuted fractures of this beauty bone.¹⁴

AIM AND OBJECTIVES

The objective of this research was to estimate the number, position, direction, and location of nutrient foramina in 100 dry adult human clavicle bones.

MATERIALS AND METHODS

Research was carried out on 100 dry clavicle bones; 50 on the right side and 50 on the left side of a human whose age and sex were unknown, in the department of anatomy at a tertiary care medical institute of Punjab, India. In this study, number, location, direction, and distance from two ends were observed. Variations observed during the study were photographed and the data collected were analyzed and compared with the literature.

- **Location:** To observe the location, the shaft of the clavicle was divided into medial one-third, middle one-third, or lateral one-third distance of nutrient foramen was measured with the help of digital Vernier caliper (Fig. 1).
- **Number of nutrient foramina:** Observe the number of nutrient foramina in each clavicle bone with the help of a hand glass and noted it down (Figs 2 and 3).
- **Position:** It was observed in the relation to different surfaces of the clavicle, that is, anterior, posterior, superior, and inferior surfaces.
- **Direction:** The needle was used to note the foramina direction whether it was present toward the acromial end or toward the sternal end (Fig. 4).

RESULTS

In this study, nutrient foramina were present in 100 clavicle bones, 50 clavicle bones (right) and 50 clavicle bones (left). Out of 100 bones, single foramina was present in 33 clavicle bones of the right (66%) and 46 clavicle bones of the left (92%) that were observed. Double foramina were present in 14 clavicles, out of which 11

clavicles of right (22%) and 3 clavicles of left (6%) were noticed (Fig. 2). Three foramina in the total 7 clavicles present, out of which, 6 clavicles of right (12%), 1 clavicle of left (2%) (Table 1; Fig. 3) were observed. Foramina directed toward the acromial end were 76.5%



Fig. 1: Distance of nutrient foramen from sternal end



Fig. 2: Clavicle bones showing double foramina



Fig. 3: Bone showing triple nutrient foramen



Fig. 4: Direction of nutrient foramen toward acromial end shown with inserted needle

Table 1: Number of nutrient foramen in each clavicle bones

Number of nutrient foramen	Right clavicle (n = 50)	Left clavicle (n = 50)	Total (n = 100)
Single foramen	33 (66%)	46 (92%)	79 (79%)
Double foramen	11 (22%)	3 (6%)	14 (14%)
Triple foramen	6 (12%)	1 (2%)	7 (7%)

Table 2: Direction of nutrient foramen

Direction of nutrient foramen	Number of nutrient foramen	Frequency (%)
Toward acromial end	104	76.4
Toward sternal end	32	23.6
Total	136	100

Table 3: Location of nutrient foramen

Location	Number of nutrient foramen	Frequency (%)
Middle one-third	102	75
Medial one-third	9	6.6
Lateral one-third	25	18.4
Total	136	100

Table 4: Position of nutrient foramen according to surfaces

Surface showing presence of nutrient foramen	Number of nutrient foramen	Frequency (%)
Anterior	3	2.3
Posterior	93	68.4
Superior	4	2.9
Inferior	36	26.4
Total	136	100

and toward the sternal end were 23.5% (Table 2; Fig. 4). Most of the nutrient foramina were present in the medial two-third of the shaft and on the posterior surface (Tables 3 and 4).

Table 5: Comparison of different studies on the number of nutrient foramen

Researchers	Number of nutrient foramen in bones		
	1 (%)	2 (%)	3 (%)
Rai et al. ¹⁷	42.5	52.5	5
Tanna and Tanna ¹³	42	52.5	6
Sahu and Meher ¹⁸	43.38	50.93	5.65
Ratnesh et al. ¹⁹	65	26.66	8.33
Joshi and Mathur ¹²	68	26	0
Sinha et al. ²⁰	70	24	6
Dakshayani and Shivanal ²¹	80	17	0
This study	79	14	7

DISCUSSION

Blood supply of a bone is vital for the healing of fractured bone and wounds.¹⁵ Nutrient arteries are the vital origin of blood supply to the bones.¹⁶ Usually, clavicle bone has one nutrient foramen present on the shaft to allow the way to main nutrient artery.¹⁷ With the help of nutrient foramen one or two main diaphyseal nutrient arteries enter the shaft obliquely, which travel into nutrient channels. Location of passage and angulation of these are almost invariable and normally pointed away from the dominant developing epiphysis.² Our research followed the universal rule that the direction of the nutrient foramen is away from the growing end according to the growing end theory. The direction of nutrient foramina in bone with the development and bone formation was correlated by some authors.¹⁷

Number of Nutrient Foramina

In our study, most of the bones presented a single nutrient foramen as shown in Table 5, which are same as Ratnesh et al.¹⁹ and Sinha et al.,²⁰ but according to Rai et al.,¹⁷ Tanna and Tanna,¹³ and Sahu and Meher¹⁸ mostly found double nutrient foramina in clavicle bones.

Position of Nutrient Foramina

According to Rai et al.,¹⁷ Tanna and Tanna,¹³ Sahu and Meher,¹⁸ Sinha et al.,²² and Dakshayani and Shivanal²¹ observed that maximum foramina were present on the posterior surface similar to our study, but Ratnesh et al.¹⁹ and Sinha et al.²² in their studies showed that nutrient foramina was also located on the superior aspect of clavicle as well like our findings mentioned in Table 6.

Direction

In our study, nutrient foramina were present on the acromial end and sternal end, but according to Tanna and Tanna¹³ and Sinha et al.²⁰ observed the direction of foramina only toward the acromial end.

Location of Nutrient Foramina

According to the undermentioned studies (Table 7) nutrient foramina were mostly located in middle one-third of the clavicle bone; similarly, in the present study, 75% of nutrient foramina were located in the middle one-third of the clavicle and a minimum number of nutrient foramina were present on medial one-third.

Table 6: Comparisons of position of nutrient foramen on various surfaces by researchers

Researchers	Anterior surface (%)	Posterior (%)	Superior (%)	Inferior (%)
Rai et al. ¹⁷	—	64.6	—	35.4
Sinha et al. ⁵	—	30	—	69.7
Tanna and Tanna ¹³	—	63.45	—	36.6
Sahu and Meher ¹⁸	—	63.1	—	36.9
Ratnesh et al. ¹⁹	—	26.74	1.16	72.09
Sinha et al. ²⁰	—	41.17	2.94	55.88
Dakshayani and Shivanal ²¹	—	87.6	—	12.4
This study	2.3	68.4	2.9	26.4

Table 7: Location of nutrient foramen in various studies

Researchers	Medial one-third (%)	Middle one-third (%)	Lateral one-third (%)
Rai et al. ¹⁷	15.4	73.8	10.8
Tanna and Tanna ¹³	18.3	72	9.8
Sahu and Meher ¹⁸	19.04	71.42	9.52
Ratnesh et al. ¹⁹	11.66	66.66	21.66
Sinha et al. ²⁰	10.29	70.58	19.11
This study	6.6	75	18.4

CONCLUSION

The acquaintance of the number, location, and direction of nutrient foramina is extremely important in surgical measures, for example, repair of the coracoclavicular ligament, bone grafting, internal fixation technique, and transplant procedures. Nutrient foramen plays an essential role in a surgical and orthopedical trials such as bone grafting and bone transplantation, and is valuable to safeguard arterial supply during radiation therapy.

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