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A Morphological & Topographical Study of Nutrient Foramina in Dry Human Clavicles of Rajasthan State

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Abstract

Introduction: *Human beings are bestowed with the power of bipedal locomotion and the clavicle acts as a strut to allow the free movement of the upper limb away from the chest wall.[2]*
The clavicle (collar bone) is an unusual long bone which has many unique embryologic features.[14]

Aims & Objectives: *The main aim of this study is to find variation in number and position of nutrient foramen of the human clavicle which enlightens the operating surgeon in the free vascularised bone grafts and in microsurgical vascularised bone transplantation.*
From recent hypothesis it has been confirmed that vascularized bone and joint allograft survival depends strongly on the blood supply of bone.[17]

Material & Methods: *Our study comprised of 50 (25 Right sided & 25 left sided) dry human clavicles collected irrespective of age and sex, obtained from department of Anatomy at S.M.S. Medical College & Hospital Jaipur.*

Results & Conclusions: *In our Present study Nutrient foramina was present in 47(97%) clavicles. Out of which single foramina in 34(68%) and double foramina in 13(26%). Absence of nutrient foramina were found in 3(6%) clavicles.*
Maximum number was present in the middle third and on the posterior surface of 38(76%) bones.
Majority of the formina were directed towards the acromial end which showed that sterna end of the clavicle was the growing End and followed the laws of ossification. Only two foramina were directed towards sterna end.
The knowledge of the nutrient foramina is essential in some surgical procedures like placement of internal fixation, in vascularised bone graft and also to preserve arterial supply during radiation therapy.

Keywords: *Nutrient foramina, clavicle, bone grafting.*

Introduction

Bones are structures that adapt to their mechanical Environment, and from a foetal age adapt to the presence of naturally occurring holes. These holes or nutrient foramina, allow blood vessels to pass through the bone cortex.[11]

The nutrient artery is the principal source of blood supply to a long bone, particularly important during its active growth period in the embryo and foetus, as well as during the early phase of ossification.[20]

Nutrient foramen is the largest foramen on the long bones through which nutrient artery for that bones passes.[5]

Nutrient foramen is an opening into the bone shaft which gives passage to the blood vessels of the medullary cavity of a bone, for its nourishment and growth.[24]

The clavicle (the Latin word) which means 'small key" [3] meets the axial skeleton at the sternoclavicular joint[9].The Clavicle is a modified long bone placed horizontally and subcutaneously at the root of neck. It also transmits the weight from upper limb to the axial skeleton.

The inferior surface of shaft of clavicle presents a subclavian groove. A Nutrient foramen lies at the lateral end of the groove running in a lateral direction. It was described that a small foramen may be present in the middle one third of the clavicle, along itss superior border. This foramen transmits the nutrient artery and at times, the supraclavicular nerve.[19]

In contrast, Knudsen et al reported that clavicle is supplied by periosteal arteries and the nutrient artery is not found.[18] however few authors suggested that suprascapular artery supplies the middle third region of the clavicle by a nutrient branch. They stated that the nutrient foramen of the clavicle is found at the junction between the lateral and middle third regions.[8,14]

In the radiological literature it was described that this foramen transmits medial fascicle of the supraclavicular nerve. Anatomically it was described that this foramen was present in 2-6% of the population.[10]

The location and number of nutrient foramina remains a non constant feature in long bones.[4]

The knowledge of nutrient foramen is important in surgical procedures like bone grafting and more recently in microsurgical vascularized bone transplantation. As these techniques are becoming popular, information relating to the anatomical description of these foramina is of vital importance to preserve the circulation of affected bony structure.[13,21]

It is also of relevance to the orthopedician involved in surgical procedure where patency of arterial supply is crucial and it should be preserved to promote fracture repair.[13,21]

In free vascular bone grafting, the nutrient blood supply is extremely important and must be preserved to promote fracture repair, a good blood supply being necessary for osteoblast and osteocyte cell survival, as well as facilitating graft healing in the recipient.[1,7]

Material and Methods

This study was conducted on 50(25right & 25 left) adult human cleaned and dried Clavicles in Department of Anatomy, .S.M.S. Medical College, Jaipur.

The specific age & sex characteristics of the bones studied were unknown.

Bones which have gross pathological deformities were excluded from the study.

Following Observation were recorded with the help of (a). Magnifying lens (b). Sliding vernier caliper (c). Guide wires and (d).24 gauge hypodermic needle (0.56 mm in diameter) -

1. **Number of Nutrient Foramina**

The Nutrient Foramina was observed in all bones with the help of a hand-lens. They were identified by their elevated margins and by the presence of a distinct groove proximal to them. Only well-defined Foramina on the diaphysis were accepted (Fig.1). Foramina at the ends of the bone were ignored.

2. **Position of Nutrient Foramina**

Their distribution over different surface was observed by direct inspection

3. **Location of Nutrient Foramina**

The location of only Dominant Foramina (admitting 0.24 size hypodermic needle) was considered and their distribution in bone length.

4. **Direction and Obliquity**

A fine stiff wire was used to confirm the direction and obliquity of the foramen.

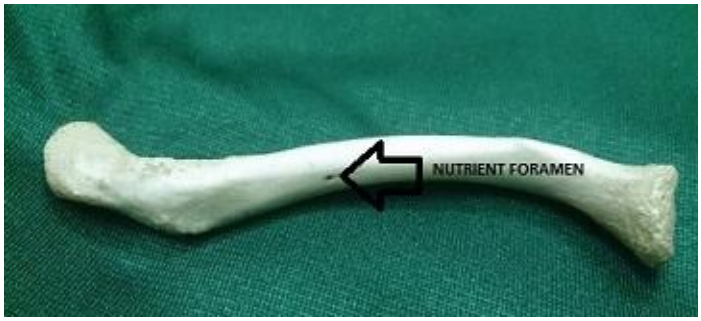

Fig-1 Nutrient foramen on Posterior surface of clavicle

Observations and Results

In the present study we observed the neurovascular foramina in 47(94%) clavicles. All the foramina were directed towards the Acromial end which gives the idea that Sternal end of clavicle is the growing end.

The single foramen in 34 (68%) clavicles, double foramina present in 13 (26%) and no nutrient foramina (Absence) present in 3clavicles (6%).[Table1]

The maximum numbers of NF were observed on posterior surface 38(76%), inferior surface 8(16%) of medial two third and 1(2%) on superior surface of lateral one third of calvicle. [Table 2]

Out of 50 clavicles 13 clavicles (26%) have additional nutrient foramina in addition to main nutrient foramina.[Table 1]

Table-1: Numbers of N.F. in studied Clavicles

	Number Of Foramina			
Name of Bone	0	1	2	3
Clavicle [N=50]	3[6%]	34[68%]	13[26%]	0

Table-2 Morphological & Topographical Distribution of Nutrient Foramina in Clavicles

Bone	Location	NO.OF NF	
		Anterior	
CLAVICLE	SURFACE[Medial2/3]	Posterior	38[76%]
		Superior	
		Inferior	8[16%]
	SURFACE[Lateral]	Superior	1[2%]
		Inferior	

Discussion

The nutrient foramen is defined as the largest foramen present on the shaft of long bone allowing nutrient artery to enter the bone, the role of which is important in providing nutrition and growth of long bones. Healing of fractures, as of all wounds, is dependent upon blood supply.[6,16]

Injury to the nutrient artery at the time of fracture, or at subsequent surgeries, may be a significant factor predisposing to faulty union.[17,22]

If surgeons could avoid a limited area of the cortex of the long bone containing the nutrient foramen, particularly during an open reduction, an improvement in the management of this problem might be attained.

Recent results confirmed the hypothesis that vascularized bone and joint allograft survival depends strongly on the blood supply of bone. Anatomical factors were suspected to be responsible for this phenomenon. Thus the knowledge of anatomy of nutrient foramina is significantly important for orthopaedic surgeons doing open reduction of fracture, in order to avoid injuring nutrient artery and there by lessens the chances of delayed or non-union of fracture.[24]

The major blood supply to long bones usually enters at particular points on shaft that determines the number of nutrient foramen.

In the present study 34(68%)clavicles were observed to posses single nutrient foramen and 13(26%) of bone shows double nutrient foramen[Table 1] which is in correlation with findings of Malukar O, Joshi H[24] but in studies of Rahul Rai et al only 42% of bone had single foramen and 52.5% of bone were with double foramen.[25]

In our study 3(6 %) clavicles showed the absence of nutrient foramina.[Table 1]

Thus the findings imply that usually shaft of clavicle contain only one significant canal which transmits the main nutrient artery of the bone.

The well-known factors, which may affect position of nutrient foramen position, are the growth rates at the two ends of the shaft and bone remodelling. The topographical knowledge of these foramina is useful in certain operative procedures to preserve the circulation.

Previous studies on clavicle suggest the posterior surface as the dominant position for nutrient foramen which is similar to our present study.

In present study no foramen is found on the superior surface [Table 2] which is in correlation with findings of Rahul Rai et al[25] but differs with study of Malukar O, Joshi H which reported 14% of foramen on this surface.[24]

An accurate knowledge of the location of the nutrient foramina in long bones would help in preventing intraoperative injuries in orthopaedic, as well as in plastic and reconstructive surgery. Preoperative planning of such procedures is vital for all such surgical interventions, together with an appropriate understanding of the extraosseous vascular supply for a successful outcome.

The knowledge of variations in the nutrient foramen, placement of internal fixation devices can be appropriately done.

Nutrient canal (through which nutrient artery enters the shaft) typically become slanted during growth, the direction of slant from surface to marrow cavity points towards the end that has grown least rapidly. This is due to greater longitudinal growth at the faster growing end.

All long bones including clavicle have two epiphysial ends while miniature long bones have only one growing end. The direction of nutrient foramen of all bones was away from growing end in their study of 100 clavicles.[24]

Berard was the first to correlate the direction of the canal with the ossification and growth of the bone.[2]

Husmphrey who worked on the direction and obliquity of nutrient canals postulated periosteal slipping theory, the canal finally directed away from the growing end.[15]

Murlimaju BV etal reported that nutrient foramen in clavicle was directed towards the acromial end.[23]

Conclusion

From the present study based on observation of Morphology and topography of diaphysial nutrient foramen in human clavicle, it was concluded that usually clavicle exhibited single nutrient foramen which was predominantly positioned on the inferior surface. The location of nutrient foramen relative to bone length were concentrated in middle one third of bone length followed by proximal one third and least likely in distal one third of bone length.

The direction of nutrient foramen was towards the acromial end thus the sternoclavicular end being the growing end.

The present study will be helpful for preserving the circulation of clavicle while performing surgical procedures like microvascular bone grafting, internal fixation and coracoclavicular ligament repair.

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