2018

www.jmscr.igmpublication.org Impact Factor 5.84 Index Copernicus Value: 71.58 ISSN (e)-2347-176x ISSN (p) 2455-0450 crossref DOI: _https://dx.doi.org/10.18535/jmscr/v6i1.07



Journal Of Medical Science And Clinical Research An Official Publication Of IGM Publication

Morphometric Study of Number, Position and Direction of Nutrient Foramen of Clavicle in Population of Bihar

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Abstract

Introduction: clavicle is the modified long bone placed horizontally and subcutaneously at the root of neck. Clavicle is the most important bone which transmits the body weight from upper limb to axial skeleton.

Objectives: The main objective of this study is to determine the number, position and direction of nutrient foramen of clavicle.

Material and Methods: The present study was conducted on 60 clavicles (30 right and 30 left) adult human dried clavicle, collected from Department of Anatomy, Department of Forensic medicine and also from first year medical students of Indira Gandhi Institute of Medical Sciences, Patna, Bihar.

Results: The nutrient foramen was present in 100% of clavicle. Single foramen was present in 65%, double foramen in 26.66% and three foramen were present in 8.33% of clavicles. The most common position of nutrient foramen was on the inferior surface in 72.09%. 66.66% of nutrient foramen were found in middle one third of clavicle. All the foramen were directed towards the acromion end of clavicle.

Conclusion: *Knowledge about the nutrient foramen of clavicle is important clinically during vascularised bone grafting to preserve the blood supply of graft.*

Introduction

The clavicle is a modified long bone placed almost horizontally at the root of the neck and is subcutaneous throughout its whole extent. The clavicle transmits the weight of upper limb to axial skeleton. The clavicle has two ends, lateral and medial and a cylindrical shaft ^[1]. The shaft is divided lateral one third and medial two third. The lateral one third of shaft is flattened from above downward, so it has two borders anterior and posterior and two surfaces superior and inferior. The anterior border is concave and posterior one is convex. The superior surface is subcutaneous and inferior surface bears an elevation called the conoid tubercle and a ridge called the trapezoid ridge.

JMSCR Vol||06||Issue||01||Page 32437-32441||January

2018

The medial two third of shaft is rounded and has four surfaces. The anterior surface is convex and posterior surface is smooth. The superior surface is smooth in its medial part and the inferior surface bears a rough oval impression on its medial part. The lateral third of inferior surface has subclavian groove. The nutrient foramen present at the lateral to subclavian groove directed laterally ^[3].

The nutrient foramen is the largest foramen on the shaft of long bones through which nutrient artery passes^[4]. The nutrient artery is the main source of blood supply of long bones during its active growth^[5] and during the early phases of ossification and some pathological conditions such as fracture healing, acute hematogenic osteomyelitis and developmental abnormalities which is closely related to vascular supply of bone^[6].

The nutrient artery of clavicle lies at the lateral to the subclavian groove directed laterally and transmits nutrient artery which is derived from suprascapular artery^[7]. The nutrient foramen of clavicle present at the junction between the lateral and middle third of clavicle ^[8].

The nutrient foramen follow the rule, "to the elbow I go, from the knee I flee" but they are very variable in position. Humphrey who worked on the direction of nutrient canal and stated that nutrient canal directed away from the growing end ^[9].

Knowledge of nutrient foramina of clavicle is useful to preserve the arterial supply during radiation therapy, placement of internal fixation devices^[10] and in free vascularised bone graft, so that the osteocytes and osteoblast can survive ^[11]. Main aim of this study was to find out the anatomical variations of number, position and direction of nutrient foramen in clavicle and their clinical correlation.

Material and Methods

The present study was conducted on 60 clavicles (30 right and 30 left) adult human dried clavicle, collected from Department of Anatomy, Department of Forensic medicine and also from first year medical students of Indira Gandhi Institute of Medical Sciences, Patna, Bihar. The clavicles which were damaged, deformed and other apparent pathological abnormalities were excluded from the study. All the bones were observed for the number, location and direction of nutrient foramina. The foraminal index was calculated using the Hughes formula-

Foraminal index (FI)= (DNS/TL) X 100

DNS- Distance of nutrient foramen from proximal or sternal end of clavicle

TL- Total length of clavicle

The location of nutrient foramen was divided into three types according to

Foraminal Index (FI)-

Type 1: Foraminal index up to 33.33, the foramen present in the proximal $1/3^{rd}$ of the clavicle.

Type 2: Foraminal index between 33.33- 66.66, the foramen present in the middle third of the clavicle.

Type 3: Foraminal index above 66.66, the foramen present in the lateral third of the clavicle.

All measurement were taken using sliding vernier calliper.

Results

The nutrient foramen was present in 60 (100%) of clavicles. Single foramen were present in 39 (65%) of clavicle, double nutrient foramen in 16 (26.66%) and three foramen were present in 5 (8.33%) of clavicles. On the right side one foramen were found in 66.66% of clavicle and left side in 63.33%. double nutrient foramen were found on right side in 23.33% and on left side in 9%. Three nutrient foramen were found on right side in 6.66% of clavicle.

Total number of nutrient foramen observed was 86. Nutrient foramen were present on inferior surface in 72.09%, on posterior surface in 26.74% and on superior surface in 1.16% of clavicle. On the right side 71.11% of nutrient foramen were present on inferior surface, 26.66% on posterior surface and 2.22% on superior surface. On the left side, 73.17% of nutrient foramen were present on posterior surface and no nutrient foramen were found on superior surface.

Number of	Right	Left (n=30	Total (60)			
nutrient	(n=30)					
foramen						
0	0	0	0			
1	20	19	39 (65%)			
	(66.66%)	(63.33%)				
2	7 (23.33%)	9 (30%)	16 (26.66%)			
3	3 (10%)	2 (6.66%)	5 (8.33%)			

Table 1 Number of nutrient foramen in clavicle

Table 2. Position of nutrient foramen of clavicle						
Surfaces	Right	Left	Total			
Inferior	32 (71.11%)	30 (73.17%)	62 (72.09%)			
Posterior	12 (26.66%)	11 (26.82%)	23 (26.74%)			
Superior	01 (2.22%)	0	01 (1.16%)			

	Right	Left	Total
Medial 1/3 rd	3 (10%)	4 (13.33%)	7 (11.66%)
Middle 1/3 rd	21 (70%)	19 (63.33%)	40 (66.66%)
Lateral 1/3 rd	6 (20%)	7 (23.33%)	13 (21.66%)

Fig.1. Clavicle with single nutrient foramen on the inferior surface in lateral one third



Fig.2. Clavicle with single nutrient foramen on posterior surface in middle third



Figure.3. Clavicle with 3 nutrient foramen on inferior, posterior and superior surfaces



Figure 4. Clavicle with single nutrient foramen on inferior surface in medial one third



Discussion

Nutrient foramen is defined as the largest foramen present on the shaft of long bone, allowing nutrient artery to enter in to the bone, the role of which is important in providing nutrition and growth of long bone. Healing of fractures depends upon blood supply ^[12,13]. Injuries to the nutrient arteries during fracture predisposing to faulty union ^[14-17].

Recent studies confirmed the hypothesis that vascularizes bone and joint allograft survival depends strongly on blood supply of bone. Thus the knowledge of nutrient foramen is important for orthopaedic surgeons during open reduction of fracture, in order to avoid injury of nutrient artery and there by lessens the chances of delayed union or non-union of fracture ^[18].

The major blood supply of long bone enters at a particular point on the shat that determines the number of nutrient foramen.

Parameter	Mulukar et al,	Murlimanju et al,	Rahulral et al,	Present study
Number of foramina	2011	2014	2014	
0	-	-	-	-
1	68%	38.5%	42%	65%
2	20%	44.2%	52.5%	26.66%
>2	11%	13.4%	6%	8.33%
Position				
Superior surface	1.4%	1.9%	-	1.66%
Inferior surface	42.5%	55.8%	35.4%	72.9%
Posterior surface	56.3%	69.2%	64.6%	26.74%
Location (Foraminal Index)				
Type 1	8.4%	9.6%	15.4%	11.66%
Type 2	59.1%	92.3%	73.8%	66.66%
Туре 3	32.3%	1.9	10.8%	21.66%
Direction of nutrient canal	Towards	Towards acromial	Towards	Towards acromial
	acronnal ellu	cilu	actonnal ellu	cilu

In this study, we found that 65% of the clavicle had single nutrient foramen, 26.66% of clavicle were double foramen and 8.33% of clavicle were three nutrient foramen. This result is very close to the study done by Mulukar et al^[19]. But in other studies done by Murlimanju et al in 2014 shows that single nutrient foramen found in 38.5% and double nutrient foramen found in 44.2% of clavicle. In the other study done by Rahulrar et al in 2014, single foramen found in 42% and double foramen found in 52.5% of clavicle.

Previous studies on clavicle shows that posterior surface is the predominant position for nutrient foramen, while in this study inferior surface is the predominant position for nutrient foramen with 72.9%.

Conclusion

Knowledge of nutrient foramen of clavicle is useful to preserve the arterial supply during radiation therapy, placement of internal fixation devices and in free vascularised bone graft, so that osteocytes and osteoblasts can survive.

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JMSCR Vol||06||Issue||01||Page 32437-32441||January

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