

THE STUDY OF NUTRIENT FORAMINA IN HUMAN CLAVICLE

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ABSTRACT

BACKGROUND

The major blood supply to the long bones is through nutrient arteries, which enter the medullary cavity of bone through the nutrient foramina. Nutrient foramen is the opening present in the shaft of long bone. Blood vessels pass through this foramen and enter the medullary cavity of a bone for its nourishment and growth. The shaft of the clavicle usually presents one nutrient foramen for the passage of main nutrient artery. With respect to the blood supply to the clavicle, there could be nutrient artery to the primary centres of ossification and to the late secondary centre at the sternal end of the clavicle. The nutrient artery is derived from the suprascapular artery. Clavicular branch of acromiothoracic artery. Knowledge regarding the nutrient foramen is important for many surgical procedures. Vascularity of the bone is considered for the various options in the grafting. The endosteal and periosteal blood supply with good anastomosis is required for the ideal bone graft.

MATERIALS AND METHODS

The study comprises of 50 clavicles, out of which, 25 belong to right side and 25 left side. The bones were obtained from the osteology section of Department of Anatomy and Forensic Medicine, TOMCH and RC, Yadavanahalli, Bangalore. The number, location and direction of nutrient foramina were observed and compared with the studies done by previous workers.

RESULTS

Totally 62 nutrient foramina were observed in 50 bones. All are directed away from the growing end of the bone. 39 (56%) bones showed single foramina, 6 (24%) showed double foramina, 1 (8%) showed 3 foramina and 2 (8%) bones showed 4 foramina. 39 (79.5%) bones had the foramina on inferior surface and 21 (84%) were on posterior surface and 2 (4%) were on anterior surface.

CONCLUSION

In our study, all the bones obey the general rule that is the direction of nutrient foramina is away from the growing end. The data obtained are coinciding with the studies done by previous workers. Information about the nutrient foramina is of clinical importance especially in surgical procedures like microvascularised bone transplantation and bone graft.

KEYWORDS

Nutrient Foramina, Clavicle, Growing End.

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BACKGROUND

Nutrient foramen is the opening present in the shaft of long bone. Blood vessels pass through this foramen and enter the medullary cavity of a bone for its nourishment and growth.¹ The shaft of the clavicle usually presents one nutrient foramen for the passage of main nutrient artery.² With respect to the blood supply to the clavicle, there could be nutrient artery to the primary centres of ossification and to the late secondary centre at the sternal end of the clavicle.³ The nutrient artery is derived from the suprascapular artery.^{3,4,5} Clavicular branch of

acromiothoracic artery.⁶ Knowledge regarding the nutrient foramen is important for many surgical procedures. Vascularity of the bone is considered for the various options in the grafting. The endosteal and periosteal blood supply with good anastomosis is required for the ideal bone graft.⁷

Aim of the Study- To study the number, direction and position of the nutrient foramina in human clavicle.

MATERIALS AND METHODS

The study included 50 dried human clavicle of unknown age and sex obtained from the Department of Anatomy and Forensic Medicine, TOMCH and RC, Yadavanahalli, Bangalore. The total length of the clavicle was measured. The clavicles were observed macroscopically for the number, direction and position of the nutrient foramen. The distance of the nutrient foramen from the sternal end was measured by using Vernier calipers. The foraminal index was calculated by using the Hughes formula, which states that FI=(DNF/TL) x 100, where DNF=The distance from the proximal end of

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the clavicle to the nutrient foramen. TL=Total length of the clavicle.

RESULTS

The measurements obtained are tabulated as below.



Figure 1. Showing Two Nutrient Foramen



Figure 2. Showing Three Foramen



Figure 3. Showing Four Nutrient Foremen



Figure 4. Tools

Number of Nutrient Foramina	Clavicle		Total	Percentage
	Right	Left		
0	1	1	2	8
1	21	18	39	78
2	3	3	6	12
3	0	1	1	2
4	0	2	2	4

Table 1. Number of Nutrient Foramen

Number	Our Study	Rahul Rai	Hetal Ben G	Nita A Tanna
Single	39 (78%)	17 (42.5%)	56 (74.6%)	21 (42%)
Double	6 (12%)	21 (52.5%)	11 (14.66%)	26 (52%)
More than 2	3 (6%)	2 (5%)	8 (8.3%)	0

Table 4. Comparison of Number of Nutrient Foramina

Position Surface	Our Study	Rahul Rai	Hetal Ben G	Nita A Tanna
Inferior	39 (62.9%)	35.4%	18 (18.75%)	49.2%
Posterior	21 (33.8%)	64.6%	76 (79.16%)	50.8%
Anterior	2 (4%)	0	2 (2.08%)	0

Table 5. Comparison of Position of Foramina

Clavicle Side	Inferior	Surface	
		Posterior	Anterior
Right	19	14	2
left	20	7	0
Total	39	21	2
Percentage	62.9	33.8	3.22

Table 2. Location of the Nutrient Foramen

Position of the Nutrient Foramen	Number of Foramen	Percentage
Middle one third	53	85.5
Medial one third	4	6.5
Lateral one third	5	8

Table 3. Position of the Nutrient Foramen in Relation to Length of Clavicle

Total number of clavicle studied are 50.

Total number of foramen found are 62.

Average length of the clavicle was 13.91.

Average distance of foramen from the sternal end was foraminal index = 65.5.

DISCUSSION

The major blood supply to the long bones is through nutrient arteries, which enter the medullary cavity of the bone through the nutrient foramen. The shaft of the clavicle presents usually one nutrient foramen for the passage of main nutrient artery.² Khundsen et al stated that the nourishment to the clavicle is through suprascapular, thoracoacromial and internal thoracic artery.³ The clavicle has no medullary cavity. It consist of spongy (trabecular) bone with a shell of compact bone, so does not depend on a nutrient artery.⁸ One or two main diaphyseal nutrient arteries enter the shaft obliquely through nutrient foramina, which lead into nutrient canals. Their site of entry and angulation are almost constant and characteristically directed away from the dominant growing epiphysis.⁴

In our study also, the direction of the nutrient foramen was away from the growing end obeying the general rule of growing end theory. Bernard was the first to correlate the direction of canal with the ossification and growth of the bone.² Humpty postulated the periosteal slipping theory. The canal finally directed away from the growing end.

Number of Foramina- Our study was correlating with Hetal Ben G's study that is single foramen were found more compared to the double. In other study, double foramen were found more compared to single foramen.^{2,3,9}

Position of Nutrient Foramen- In our study, the position was more on the inferior surface, but in other study, the foramen were situated more on the posterior surface.^{2,3,9} Clavicle showed more variation as to the surface on which it was present. Knowledge of localisation of nutrient foramen is useful in surgical procedures to preserve the circulation.¹⁰

Since, the clavicle is significant source for bone grafting, the awareness of position of nutrient foramen is very helpful.⁹ Nutrient vessels occupying the nutrient foramina are usually derived from the vessels, which took part in the initial invasion of the ossifying cartilage, so that the nutrient foramen is at the original center of ossification.¹¹

Location in Relation with the Length of the Clavicle	Our Study	Rahul Rai	Hetal Ben G	Nita A Tanna
Middle one third	85.5%	73.8%	82.29%	72%
Medial one third	6.5%	15.4%	8.33%	18.3%
Lateral one third	8%	10.8%	9.37%	9.8%

Table 6. Comparison of Location of Nutrient Foramen in Relation with the Length of the Clavicle

Number- In our study, total number of foramen found were 62 out of 50 clavicle. 39 (78%) clavicle showed the single foramen, 6 (12%) clavicle showed double foramen and 1 (2%) showed four foramen. In 2 (4%) clavicles, no foramen was found. In Muralmanju's study, total foremen studied were 52.20 (38.5%) showed single, 23 (44.2%) showed double and more than 2 foramen in 7 (3.4%) clavicle were seen.¹⁰ In study, total number of foramen were 82, single seen in 21 (42%) and double in 26 (33.8%) clavicles.

Position- 39 (62.9%) foramen were found on the inferior surface, 21 (33.8%) were on posterior surface and 2 (3.22%) were found on the anterior surface. But, in 10 study, 55.8% were on the inferior surface and 69.2% were on posterior surface and 1.9% was on superior surface.¹⁰ In 11 study, 49.2% were on the inferior surface and 50.8% were on the posterior surface.⁹

Nutrient vessels occupying the nutrient foramina are usually derived from the vessels, which have taken part in the initial invasion of the ossifying cartilage, so that the nutrient foramen is at the original centre of ossification.¹¹ Clavicle showed more variation as to the surface on which it was present.¹²

Location in Relation with the Length of the Clavicle- 53 (85.5%) foramen were present on the middle one third, 4 (6.5%) on the medial one third and 5 (8%) were on the lateral one third. In study 10 showed 92.3% were on middle one third, 9.6% were on medial one third and 1.9% were on lateral one third. In study 11, 72% were on middle one third, 18.3% were on medial one third and 9.8% on lateral one third. So, our study is also correlating with the other studies, i.e. the location of nutrient foramina was more on the middle one third of the clavicle.

Clinical knowledge of nutrient foramen is helpful for the professionals to select the osseous section levels of the receptor in order to place the graft without damaging the nutrient artery, thus preserving the diaphysis vascularisation.

CONCLUSION

The study was correlated and confirmed with previous reports regarding number, direction and position of nutrient foramen in clavicle. The direction was away from the growing end. They were present more on the middle one third and on inferior surface. Most of them had single

foramina. The statistical data will be useful for the professionals who performs surgeries of bone like transplant techniques and bone grafting specially free vascular bone grafting where the nutrient blood supply is extremely important.

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