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Original Research Article

Nutrient Foramen of Clavicle: An Anatomic and Morphometric Analysis

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Abstract

Aim: The aim of the present study was to determine the morphometrical and topographical variations of nutrient foramina in human clavicles.

Methods: The study material consisted of 80 dry human clavicles of unknown age and sex, without any deformity or fracture, which were collected from the Department of Anatomy. All the bones were macroscopically observed using magnifying handlens for the number, position and direction of the nutrient foramina. The nutrient foramina were identified by the presence of a well marked groove and often with slightly raised edge at the commencement of the canal. The distance of foramina from the sternal end & the total length of the clavicle were measured in millimeters, ignoring curves of clavicle.

Results: The foramina were single in 35(43.75%) clavicles, double in 40 cases (50%), and more than two foramina in 5 clavicles (6.25%). Most of the right clavicles contained single foramina (28.75%) whereas left clavicles contained double foramina (31.25%). Three foramen were found in 2 clavicle of right side and 3 clavicles in left side. Total 130 number of nutrient foramen was found, out of which, 39.23% foramen were on inferior surface and 60.77% foramen were on posterior surface of the clavicles. Percentage of clavicle containing nutrient foramina on inferior surface was 46.67% and on posterior surface was 53.33%. Total number of clavicles considered was 90 as some clavicles contained nutrient foramen on both posterior and inferior surfaces. We found 19.23% foramens at the medial 1/3 region, 71.54% at the middle 1/3 region and 9.23% at the lateral 1/3 region of the shaft of the clavicles. Percentage-wise calculation of clavicles containing these foramens at different regions was also done. Total number of clavicles were 90 as some clavicles contained more than one foramina at different regions (medial, middle or lateral). In our study 62.22% of clavicles contained nutrient foramen in middle one third region, 24.44% contained on medial one third and 13.33% on lateral one third.

Conclusion: Nutrient foramina vary in their position, number and distribution on the bone surface. Knowledge of nutrient foramen is helpful in surgical procedures like bone grafting and in microsurgical bone transplantation.

Keywords: Clavicle, nutrient foramen, foramen index, sternal end, growing end.

Introduction

Nutrient foramen is an opening into the bone shaft for passage of blood vessels into the bone for its nourishment and growth, which is very vital for its development in the embryonic and fetal life[1] The clavicle it develops intramembranous and is the last bone to complete ossification and first to begin the process[2] It is the only long bone to lie horizontally displaying a double curvature. As known all bones have nutrient foramen, classically literatures describes that the clavicle has a small foramen present at the superior border at the middle one third of the bone transmitting nutrient artery and occasionally supraclavicular nerve[2] Various authors observed that Clavicle is supplied by periosteal artery and suprascapular artery[3] In contrast, in one study it was reported that clavicle is supplied only by periosteal arteries and the nutrient artery is not found[4] However, the nutrient foramina of the clavicle are clinically important as these are involved in the repair of clavicular fracture, which produces obvious neurovascular complication like supraclavicular nerve entrapment syndrome and brachial plexus injury. The traditional view that the vast majority of clavicular fractures heal with good functional outcomes following nonoperative treatment is no longer valid. Recent studies have identified a higher rate of nonunion and specific deficits of shoulder function in subgroups of patients with these injuries[5]Thus, orthopedic procedures like nail plating, K wire fixation and more recently microsurgical vascularized bone transplantation are becoming popular. 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. 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[6,7]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[8,9]

Materials and Methods

The study material consisted of 80 dry human clavicles of unknown age and sex, without any deformity or fracture, which were collected from the Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India. for 12 months .All the bones were macroscopically observed using magnifying handlens for the number, position and direction of the nutrient foramina. The nutrient foramina were identified by the presence of a well marked groove and often with slightly raised edge at the commencement of the canal. The distance of foramina from the sternal end & the total length of the clavicle were measured in millimeters, ignoring curves of clavicle. The foramen index was calculated by applying the Hughes formula: FI = (DNF/TL) x 100. DNF = the distance from the proximal end (sternal end) of the clavicle to the nutrient foramen. TL = total length of clavicle[10]

Results

The foramina were single in 35(43.75%) clavicles, double in 40 cases (50%), and more than two foramina in 5 clavicles (6.25%). Most of the right clavicles contained single foramina (28.75%)

whereas left clavicles contained double foramina (31.25%). Three foramen were found in 2 clavicle of right side and 3 clavicles in left side (Table 1).

Table 1: No. of Nutrient Foramen in Clavicles

Number of Nutrient Foramen	Right Clavicle (n=40)	Left Clavicle (n=40)	Total (n=80)
One	23(28.75%)	12 (15%)	35 (43.75%)
Two	15 (18.75%)	25 (31.25%)	40 (50%)
Three	2 (2.5%)	3(3.75%)	5 (6.25%)

Total 130 number of nutrient foramen was found, out of which, 39.23% foramen were on inferior surface and 60.77% foramen were on posterior surface of the clavicles. Percentage of clavicle containing nutrient foramina on inferior surface was 46.67% and on posterior surface was 53.33%. Total number of clavicles considered was 90 as some clavicles contained nutrient foramen on both posterior and inferior surfaces (Table 2).

Table 2: Showing surface-wise distribution of Nutrient Foramen in Clavicles

Surface	Number of Nutrient Foramen	Number of Clavicle
Inferior	51 (39.23%)	42 (46.67%)
Posterior	79 (60.77%)	48 (53.33%)
Total	130	90

We found 19.23% foramens at the medial 1/3 region, 71.54% at the middle 1/3 region and 9.23% at the lateral 1/3 region of the shaft of the clavicles. Percentage-wise calculation of clavicles containing these foramens at different regions was also done. Total number of clavicles were 90 as some clavicles contained more than one foramina at different regions (medial, middle or lateral). In our study 62.22% of clavicles contained nutrient foramen in middle one third region, 24.44% contained on medial one third and 13.33% on lateral one third (Table 3).

Table 3: Showing length-wise distribution of Nutrient foramen in clavicle

Region of Clavicle	Number of Nutrient Foramen	Number of Clavicle
Medial 1/3 rd	25(19.23%)	22 (24.44%)
Middle 1/3 rd	93 (71.54%)	56(62.22%)
Lateral 1/3 rd	12 (9.23%)	12 (13.33%)
Total	130	90

Average distance of the foramina from the sternal end was found to be 65.3 mm (6.53 cm) and the average total length of clavicles was 130.23mm resulting in the mean foraminal index of 50.77 (Table 4).

Table 4: Foramen Index

DNF in mm.	TL in mm.	FI
65.3	130.23	50.77

Direction of all nutrient foramina were found to be away from the growing end i.e. away from the sternal end.

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[11,12]Injury to the nutrient artery at the time of fracture, or at subsequent surgeries, may be a significant factor predisposing to faulty union[13,16]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[17]

Total 130 number of foramina were found in all 80 clavicles and most of the clavicles (50%) presented double foramina. Most of the foramina were present in middle third region (71.54%) and also on posterior surface (60.77%) of the study clavicles. Similarly most of the study clavicles presented the nutrient foramina in middle third region (66.10%) and also in posterior surface (50.82%). Rai *et al*. studied total 65 foramina in 40(100%) clavicles where 15.4% foramina were present at medial 1/3rd region, 73.8% at middle 1/3 rd region and 10.8% at lateral 1/3 rd region; 35.4% foramina were on inferior surface and 64.6% on posterior of clavicles[18]Murlimanju *et al*. found single nutrient foramina in 20 (38.5%) clavicles, two foramina in 23 (44.2%) specimens, and more than two foramina in 7 (13.4%) clavicles[19] Foramina were present at middle 1/3rd region in 92.3% clavicles, at medial 1/3rd region in 9.6%, and at lateral 1/3rd region in 1.9% clavicles; on inferior surface in 55.8% clavicles, on posterior surface in 69.2%, and on superior surface only in 1.9%. The average distance of the foramen from sternal end was 64.4 mm, and the mean foraminal index was 44.72. Thus foramina were more common on posterior surface and were often multiple, directed toward the acromial end. In our study, Average distance of the foramina from the sternal end was found to be 65.3 mm (6.53 cm) and the average total length of clavicles was 130.23mm resulting in the mean foraminal index of 50.77. The findings of the present study are similar to those of Rai *et al*. who found the average distance of the nutrient foramen from the sternal end to be 67.6 mm and the mean foraminal index to be 48.01.

Conclusion

Nutrient foramina vary in their position, number and distribution on the bone surface. Knowledge of nutrient foramen is helpful in surgical procedures like bone grafting and in microsurgical bone transplantation.

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