

TOPOGRAPHIC ANATOMY AND MORPHOLOGY OF NUTRIENT FORAMEN OF THE CLAVICLE: AN OSTEOLOGICAL STUDY

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ABSTRACT: OBJECTIVE: To study the topographical and morphological aspects of nutrient foramen of the human clavicle. **METHODS:** 52 adult dry human clavicles irrespective of sex and age were studied macroscopically with help of magnifying glasses the data were collected on a standardized sheet and morphologically analyzed. The distance of the from sternal end was also determined. **OBSERVATION:** neurovascular foramina were observed in 50 (96.1%) clavicles and found absent in 2 clavicles (3.9%). The foramen was single in 20 (38.5%) clavicles, double in 23 cases (44.2%) and 7 clavicles (13.4%) had more than 2 foramina (Fig. 1D). In 48 clavicles (92.3%), the foramen was observed in the middle 1/3 region (Fig. 2A). In 5 clavicles (9.6%), the foramen was at the medial 1/3 region (Fig. 2B) and in one clavicle (1.9%), it was seen on the lateral 1/3 (Fig. 2C). The average distance of the foramen from the sternal end was 6.23cm. In 29 (55.8%) of the clavicles, the foramen was on the inferior surface (Fig. 1B). Whereas 36 (69.2%) clavicles, the foramen was observed on the posterior surface (Fig. 1A). Only one clavicle (1.9%) had the foramen at its superior surface (Fig. 1C). **CONCLUSION:** In the present study we observed the neurovascular foramina in 96.1% of the clavicles. Most of the foramina (96%) were directed towards the acromial end which gives the idea that sternal end of clavicle is the growing end. The presence of nutrient foramen in the posterior surface in significant number of cases contradicts the classical presentation in its inferior surface. Knowledge of the localization of nutrient foramina can be useful in certain surgical procedures to preserve the circulation. Microvascular bone transfers' being more popular now, this study helps to focus towards a better approach.

KEYWORDS: Clavicle, nutrient foramina, periosteal arteries, neurovascular foramina.

INTRODUCTION: The clavicle (collar bone) is an unusual long bone which has many unique embryologic features. It is the first bone to ossify and intramembranous in origin.^[1] It is a horizontally placed, 'Y' shaped, tubular bone that connects the appendicular and axial skeletons. It was described that a small foramen may be present in the middle one third of the clavicle, along its superior border. This foramen transmits the nutrient artery and at times, the supraclavicular nerve.^[1] In contrast, Knudsen et al.^[2] reported that clavicle is supplied by periosteal arteries and the nutrient artery is not found. However few authors^[3, 4] 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.

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.^[5] It was reported that it is not uncommon to see multiple foramina which are

more at the junction between middle and lateral thirds. Other than these few reports, the data on the foramina of the clavicle are not found. The knowledge of the neurovascular foramina of the clavicle is clinically important as these are involved in the supraclavicular nerve entrapment syndrome.^[6] The topography and morphology of these foramina is enlightening for the operating surgeon in the free vascularised bone grafts and in microsurgical vascularised bone transplantation. The aim of the present investigation was to study the topographic anatomy and morphology of the neurovascular foramina in human adult clavicles.

MATERIALS AND METHODS: The study included 52 adult clavicles (27 right sides and 25 left) which were obtained from the osteology section of the anatomy laboratory of our department. The age and sex of the clavicles were not determined. The clavicles were not having external deformities. All the bones were macroscopically observed for the number, location and direction of the nutrient foramina. A magnifying lens was used to observe the foramina. The data were collected on a standardized sheet and morphologically analyzed. The distance of the from sternal end was also determined.

RESULTS: The neurovascular foramina were observed in 50(96.1%) clavicles and found absent in 2 clavicles (3.9%). The foramen was single in 20(38.5%) clavicles, double in 23 cases (44.2%) and 7 clavicles (13.4%) had more than 2 foramina (Fig. 1D). In 48 clavicles (92.3%), the foramen was observed in the middle 1/3 region (Fig. 2A). In 5 clavicles (9.6%), the foramen was at the medial 1/3 region (Fig. 2B) and in one clavicle (1.9%), it was seen on the lateral 1/3 (Fig. 2C). the average distance of the foramen from the sternal end was 6.23cm. In 29 (55.8%) of the clavicles, the foramen was on the inferior surface (Fig. 1B). Whereas 36(69.2%) clavicles, the foramen was observed on the posterior surface (Fig. 1A). Only one clavicle (1.9%) had the foramen at its superior surface (Fig. 1C). The topographical distribution of the nutrient foramina with respect to sides is summarized in Table 1. In 48 (96%) clavicles, the foramina were directed towards the acromial end and 2(4%) clavicles had the medially directed foramina. Fig. 3 shows the radiological visualization of the nutrient foramina of the clavicle.

DISCUSSION: Nutrient arteries which are the main blood supply to long bones are particularly vital during the active growth period and at the early phases of ossification.^[7] These nutrient arteries pass through the nutrient foramina, the position of nutrient foramina and the direction of nutrient canal in mammalian bones are variable and may alter during the growth.^[8] There are few studies available which reported the morphology of nutrient foramina of upper limb, lower limb long bones,^[9, 10] metacarpal, metatarsal bones^[11] and phalanges.^[12] But the detailed study reporting the morphology of the foramina of the clavicle has not been reported hitherto. Knudsen et al.^[2] opined that clavicle gets the nourishment by the suprascapular, thoracoacromial and internal thoracic arteries. According to these authors the clavicle is supplied by periosteal arteries and not by the nutrient artery. The nutrient foramen was explained as the site of major venous drainage. The absence of nutrient artery to the clavicle can be explained by the fact that, unlike other long bones, it does not have a medullary cavity^[13] and is therefore does not dependent on a nutrient artery.^[2] Few authors hypothesize that with respect to the development of the blood

supply to the clavicle, there could be nutrient artery to the primary centers of ossification and to the late secondary center at the sternal end of the clavicle.^[2]

In the present study we observed the neurovascular foramina in 96.1% of the clavicles. Most of the foramina (96%) were directed towards the acromial end which gives the idea that sternal end of clavicle is the growing end. The present study supports the reports of Fischer and Carret,^[3] Kumar et al.^[1] and Havet et al.^[4] that the clavicle has nutrient foramina and supplied by the nutrient artery. This study also supports the reports of Rahul Rai and Shailaza Shrestha^[14] that the average distance of the foramen from sternal end lies between 6-7cm. We observed multiple neurovascular foramina in some clavicles (Fig. 1D). The foramen was single in 38.5% clavicles, the double foramen was observed in 44.2% cases and in the 13.4% clavicles there were more than 2 foramina. The present study also studied the topography of these foramina, 92.3% of the foramina were observed in the middle 1/3 region (Fig. 2A), 9.6% were found at the medial 1/3 region (Fig. 2B) and in one clavicle it was seen on the lateral 1/3 region (Fig. 2C). Standard text books of anatomy state that the foramina were present at the inferior surface. But in the present study we observed that, in 69.2% of the cases the foramina were present at the posterior surface (Fig. 1A) and were present at the inferior surface in 55.8% of the clavicles (Fig. 1B). Only one clavicle had foramen at its superior surface (Fig. 1C).

The middle third region of the clavicle is most commonly involved in any type of injury and account for 5–10% of all fractures in adults.^[4] Havet et al.^[4] described the arterial supply of the clavicle to clarify the pathological mechanism and the surgical procedure of non-unions. They reported that periosteal artery was always present on the superior surface and anterior border of the clavicle, but never on the inferior surface or posterior border. Their results showed that the periosteal arteries located between the muscular insertions could be compromised in case of displacements or fracture. They concluded that, if the clavicular fractures or non-unions cannot preserve the periosteal blood supply, bone grafting should be done.

Kumar et al.^[1] reported that these nutrient foramina contain medial fascicle of the supraclavicular nerve along with the nutrient artery. Gelberman et al.^[6] defined the supraclavicular nerve entrapment syndrome, the nerve injury has been attributed to the location of branch of supraclavicular nerve in the narrow canal of the clavicle.^[15] Shohei et al.^[16] reported that they have treated two patients who had entrapment neuropathy of the supraclavicular nerve attributable to an osseous tunnel of the clavicle and decompression of the entrapped nerve relieved symptoms in both patients. Jeleu and Surchev^[8] suggested that in addition to the bony canals through the clavicle certain fibrous and muscular structures could also be an anatomical basis for supraclavicular nerve entrapment syndrome.

CONCLUSION: The studies on the foramina of the collar bone are scarce. The present study has provided additional information about the topographical anatomy and morphology of the foramina of this bone. In the present study, the neurovascular foramen was observed in 96.1% of the clavicles. In the classical anatomy text books, it was described that this foramen is present on its inferior surface. But our findings suggest that it is more common on its posterior surface. The foramen is often multiple and directed towards the acromial end. Knowledge of the localization of nutrient foramina can be useful in certain surgical procedures to preserve the circulation. As

microvascular bone transfer is becoming more popular, we believe that a convention for the accurate anatomical description of these foramina is important.

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Topography of NF	Right side	Left side	Total
at posterior surface	17 (45.9%)	19 (65.5%)	36 (69.2%)
at inferior surface	20 (54.1%)	9 (31%)	29 (55.8%)
at superior surface	nil	1 (3.5%)	1 (1.9%)
at middle 1/3 part	26 (92.8%)	22 (84.6%)	48 (92.3%)
at medial 1/3 part	1 (3.6%)	4 (15.4%)	5 (9.6%)
at lateral 1/3 part	1 (3.6%)	Nil	1 (1.9%)

Table 1: Showing the topographical distribution of the NF of the clavicle with respect to side

NF – nutrient foramina



FIGURE 1

Fig. 1: Clavicles showing the nutrient foramen (arrow mark) (A) at the posterior surface; (B) at the inferior surface; (C) at the superior surface; (D) clavicle showing multiple neurovascular foramina.



FIGURE 2

Fig. 2: Clavicles showing the nutrient foramen (arrow mark) (A) at the middle 1/3 region; (B) at the medial 1/3; (C) at the lateral 1/3 region.

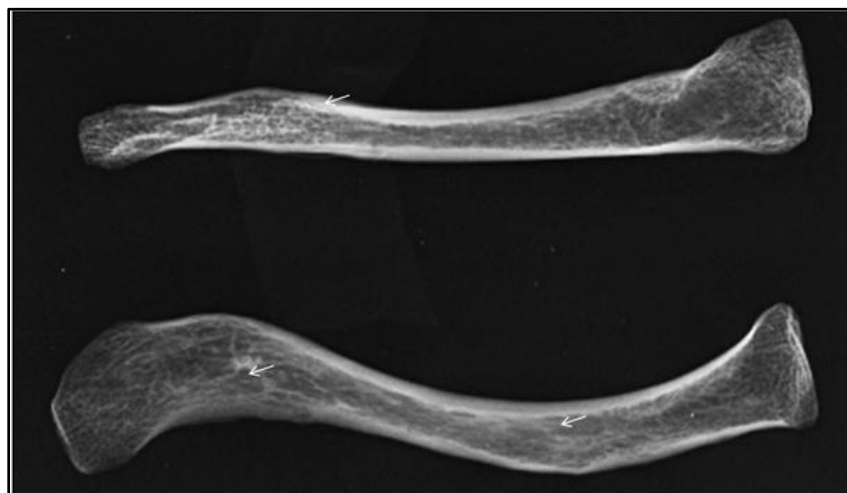


FIGURE 3

Fig. 3: Radiographic films of clavicles showing the nutrient foramen (arrow mark).

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