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A Morphometric Analysis to Investigate the Variations in the Number, Position, and Direction of Nutrient Foramina in the Clavicle

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Abstract

Background: The clavicle is a horizontally positioned, bent, and modified long bone located at the base of the neck. It transfers the force exerted by the upper limb to the axial skeleton. A morphometric analysis to investigate the variations in the number, position, and direction of nutrient foramina in the clavicle. **Methodology:** It was at the department of Anatomy that this research was carried out. In this investigation, we included a total of fifty dried clavicle bones from human subjects. Studying lasted for a total of one year during the course of its existence. Those bones that were injured, misshapen, or had a significant pathological anomaly were not included in the research under consideration. All of the clavicles were examined to determine the number of nutritional foramina, as well as their position, location, and orientation within. In order to analyze the data, Microsoft Excel was used. **Results:** For this work, we examined 50 desiccated human clavicle bones and made macroscopic observations. We discovered that a single foramen was present in 66% of the bone samples. Among the clavicle bones, 26% had two nutrient foramen, whereas 8% had three nutrient foramen. The research found that 62% of nutritional foramen were located on the inferior surface, 36% were located on the posterior surface, and 2% were located on the superior surface. There were nutritional foramen present at a rate of 10% in the medial 1/3rd, 68% in the middle 1/3rd, and 22% in the lateral 1/3rd. **Conclusion:** It may be inferred that the clavicle has a single nutrient foramen that is mostly located on the lower surface. The nutritional foramen was most often found in the center one-third of the bone length, followed by the lateral one-third and finally the medial one-third. The nutritional foramen was oriented towards the acromial end. The results of this research may be used to protect the blood flow in surgical procedures such as internal fixation and vascularized bone graft.

Keywords: Clavicle Bone, Vascularised, Internal Fixation, Nutrient Foramina.

INTRODUCTION

The clavicle is a horizontally positioned modified long bone located at the base of the neck, which is well recognized. It is subcutaneous over its whole length. The clavicle carries the weight of the upper limb and transfers it to the axial bone. The clavicle has two extremities, namely lateral and medial, in addition to a cylindrical shaft.[1] The shaft is partitioned into a lateral one-third and a medial two-thirds. The upper portion of the shaft is compressed laterally, causing it to become flattened. The object has two boundaries, one in the front and one in the back, as well as two sides, one above and one below. The front border of the object is concave, whereas the posterior edge is convex. The uppermost layer is located under the skin. The underside has a raised area. The anatomical structure is referred to as the conoid tubercle, while the elevated linear feature is known as the trapezoid ridge. The middle two-thirds of the shaft is curved and has four sides. The front surface is curved outward, whereas the posterior surface is even and without irregularities. The upper surface is smooth in its middle section, whereas the lower surface has a rough oval indentation in its middle section. The subclavian groove is located on the lateral third of the inferior surface.[2] The nutritional artery traverses via the nutrient foramen, which is the most sizable opening located on the shaft of long bones.[3]

This artery supplies the bulk of blood to long bones throughout their vigorous development and the first stages of ossification. In pathological circumstances such as developmental defects, acute haematogenic osteomyelitis, and fracture repair, the nutritional artery serves as the primary source of blood flow to bones.[4,5] The nutritious artery, which originates from the suprascapular artery, is located laterally to the laterally directed subclavian groove at the clavicle. In the clavicle, the nutrient foramen, through which the artery travels, is situated at the intersection of the middle and lateral third of the clavicle. The position and quantity of nutrition foramina in long bones are not consistent.[6-8] A nutritional foramen is located at the lateral end of the subclavian groove, traveling in a lateral direction [9]. Conversely, a research has indicated that the clavicle is only fed by periosteal arteries, with no presence of a nutritional artery.[10] Conversely, the nutritional foramina of the clavicle have significant therapeutic relevance. These structures are responsible for repairing clavicular fractures, which may result in neurovascular complications such as supraclavicular nerve entrapment syndrome and brachial plexus damage. Traditionally, it was believed that the majority of clavicular fractures heal and result in positive functional results. The nonoperative therapy is now obsolete. A recent study has shown that some groups of individuals with these injuries had a greater incidence of nonunion and particular impairments in shoulder function.[11] Thus, orthopedic techniques such as nail plating, K wire fixation, and more recently microsurgical

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vascularized bone transplantation have gained significant popularity. The understanding of the nutrient foramen is crucial in surgical techniques such as bone grafting and microsurgical vascularized bone transplantation. Currently, these strategies are quite popular. Understanding the anatomical description of these foramina is crucial for maintaining the circulation of the afflicted bony tissue. It is important for orthopedic surgeons who perform surgical procedures that need the preservation of arterial blood flow to assist fracture healing.[12,13]

In free vascular bone grafting, the nutrient blood supply is very important. It must be preserved to promote fracture repair, a good blood supply for osteoblast and osteocyte cell survival and to facilitate graft healing in the recipient.[14,15] Information regarding the anatomical description of nutrient foramen of clavicle is important to preserve the circulation of affected bony structure. Therefore, the aim of this study was to explore the morphometry and topography of nutrient foramen in clavicle. Clavicle is generally known as collar bone. It is the only long bone that lies horizontally in the body at the root of neck. It resembles like the Latin letter 'f'. It differs from other long bones as it develops in membrane. It is also devoid of medullary cavity. The major blood supply to the clavicle bone is through nutrient artery, which enters the bone through the nutrient foramina for its nourishment and growth. Nutrient foramen is the opening present in the inferior surface of the shaft which is lateral to the subclavian groove of clavicle.[16] The shaft of the clavicle generally presents one nutrient foramen for the passage of main nutrient artery.[17] For 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.[18,19] In contrast, Knudsen et al. found that clavicle is supplied by periosteal arteries and the nutrient artery is not found.[10]

METHODS

It was at the department of Anatomy that this research was carried out. In this investigation, we included a total of fifty dried clavicle bones from human subjects. Studying lasted for a total of one year during the course of its existence. Those bones that were injured, misshapen, or had a significant pathological anomaly were not included in the research under consideration. All of the clavicles were examined to determine the number of nutritional foramina, as well as their position, location, and orientation within. In order to analyze the data, Microsoft Excel was used.

RESULTS

For this work, we examined 50 desiccated human clavicle bones and made macroscopic observations. We discovered that a single foramen was present in 66% of the bone samples. Among the clavicle bones, 26% had two nutrient foramen, whereas 8% had three nutrient foramen. The research found that 62% of nutritional foramen were located on the inferior surface, 36% were located on the posterior surface, and 2% were located on the superior surface. There were nutritional foramen present at a rate of 10% in the medial 1/3rd, 68% in the middle 1/3rd, and 22% in the lateral 1/3rd.

Table 1: Distribution of cases according to Number of nutrient foramina in clavicle

Number of nutrient foramina	Right (25)		Left (25)		Total (50)	
	Number	Percentage	Number	Percentage	Number	Percentage
1	17	68	16	64	33	66
2	6	24	7	28	13	26
3	2	8	2	8	4	8

Table 2: Position of foramen in clavicle

Surface	Right		Left		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Inferior	14	56	17	68	31	62
Posterior	10	40	8	32	18	36
Superior	1	4	0	0	1	2

Table 3: Distribution according to nutrient foramen of clavicle

	Right		Left		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Medial 1/3rd	2	8	3	12	5	10
Middle 1/3rd	18	72	16	64	34	68
Lateral 1/3rd	5	20	6	24	11	22

DISCUSSION

Nutrient arteries are the primary source of blood flow to the bones. The clavicle bones typically possess a single nutrition foramen. It is located on the shaft to allow the major nutritional artery to flow through. The clavicle lacks a medullary cavity. The structure is composed of trabecular bone surrounded by a layer of cortical bone. Consequently, it is not reliant on a nutritional artery. The shaft is penetrated by one or two primary diaphyseal nutrient arteries, which enter obliquely via nutrient foramina. It connects to the nutrient canal. Their point of entrance and angulation often remain consistent and are distinctively oriented away from the prominent developing epiphysis.[16] The current research adhered to the fundamental principle of the growing end hypothesis, which states that the nutrient foramen's orientation is in the opposite direction of the developing end. Bernard was the first person to establish a correlation between the orientation of the nutrition foramen and the ossification and development of the bone.

The clavicle is a horizontally positioned, curving long bone located near the base of the neck. The upper limb is extended out from the trunk to allow for unrestricted movement and to transfer the weight of the upper limb to the axial skeleton. The clavicle has a cylindrical shaft along with two ends, namely sternal (medial) and acromial (lateral). The lateral one third of the shaft is compressed, resulting in two surfaces (superior and inferior) and two boundaries (anterior and posterior). The middle two-thirds of the shaft is cylindrical and contains four surfaces: anterior, posterior, superior, and inferior. The subclavian groove is located on the inferior surface of the clavicle shaft. The nutritional foramen is often positioned on the side of the subclavian groove, which is oriented towards the side.[20,21]

The nutritional artery of the clavicle originates from the suprascapular artery.[6] The nutrient artery is the primary provider of blood to the long bone throughout its period of active development. The nutrition foramen of all bones is oriented away from the developing end.[22] Lutken discovered that the location of that foramen may be ascertained by a thorough examination of human bone.[23] Having a precise understanding of the site, direction, and quantity of nutritional foramen is crucial in surgical and orthopedic procedures.[24] In order to ensure the successful healing of a fracture and the survival of osteocytes and osteoblasts, it is crucial to maintain the arterial supply.

The primary aim of this research was to assess the variability in the location, orientation, and quantity of nutritional foramina in the clavicle, as well as their clinical significance. The results of the current investigation revealed that 66% of clavicles exhibited a single nutrition foramen, whereas 26% of clavicles had two foramina, and 8% of clavicles possessed three nutrient foramina. Malukar et al,[27] have reported similar results. On the other hand, a research conducted by Rahul Rai et al revealed that 42.5% of clavicles had one nutritional foramen, 52.5% had two foramina, and 5% had three foramina.[17] The nutritional foramen was found to be more prevalent on the inferior surface, accounting for 72% of cases in this research. The results were corroborated by the investigations conducted by Malukar et al,[27] (56.3%) and Rahul rai et al,[17] (64.6%). Ruchi Ratnesh et colleagues demonstrated that the nutritional foramen is predominantly located on the inferior surface, accounting for 72.9% of cases. In this research, it was shown that the nutritional foramen is mostly located in the middle one third (66.7%) of the sample population. Rahul Rai et al discovered similar results, with a percentage of 73.8%. The results also indicated that the average distance between the nutritional foramen and the sternal end was measured to be 69.66 mm, while the foramen index was determined to be 52.27. Rahul Rai and colleagues,[17] discovered that the average distance from the sternal end to the foramen was 67.6 mm, and the foramen index was 48.01. In their research, Sinha P et al,[28] found that the average distance of the foramen from the sternal end was 65.8 mm, and the foramen index was 52.06.

CONCLUSION

It may be inferred that the clavicle has a single nutrient foramen that is mostly located on the lower surface. The nutritional foramen was most often found in the center one-third of the bone length, followed by the lateral one-third and finally the medial one-third. The nutritional foramen was oriented towards the acromial end. The results of this research may be used to protect the blood flow in surgical procedures such as internal fixation and vascularized bone graft.

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