Original Research Article

Morphometric Study in the Variations of Number, Position and Direction of Nutrient Foramen in the Clavicle

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Abstract

Introduction: Clavicle is a curved modified long bone placed horizontally at the root of neck. It transmits the weight of upper limb to the axial skeleton. The aim of this study is to determine position, number, and direction of nutrient foramen.**Methodology:** This study was conducted in department of Anatomy, CIMS Medical college, Bilaspur, Chattisgarh. In this study we included total 60 dried human clavicle bones. Duration of study was over a period of one year.**Results:** This study revealed the different number, position & direction of nutrient foramina of clavicle. It was found that in 65 % bone one foramen was present, while two nutrient foramen was present in 26.7% clavicle bones & three nutrient foramen in 8.4% clavicle bones.**Conclusion:** The study of number, position, location and direction of nutrient foramina of clavicles are useful to preserve the arterial supply during surgical procedure like internal fixation and vascularised bone graft.

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

Introduction

It is well known that the clavicle is a modified long bone placed almost horizontally at the root of the neck. It 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 as well as a cylindrical shaft[1]. The shaft is divided into lateral one third and medial two third. The lateral one third of shaft is flattened from above downwards. It has two borders, anterior and posterior as well as two surfaces, superior and inferior. Its anterior border is concave while posterior border is convex. The superior surface is subcutaneous. Inferior surface bears an elevation. It is called the conoid tubercle and a ridge called the trapezoid ridge. The medial two third of shaft is rounded and has four surfaces. The anterior surface is convex while posterior surface is smooth. The superior surface is smooth in its medial part whereas the inferior surface bears a rough oval impression on its medial part. The lateral third of inferior surface has subclavian groove[2]. The nutrient artery passes from the nutrient foramen which is the largest foramen on the shaft of long bones[3].The majority of blood to long bones during its active growth as well as during the early phases of ossification is provided by this artery[4].The nutrient artery is the main source of blood supply to bones in pathological conditions such as developmental abnormalities, acute haematogenic osteomyelitis and fracture healing[5]. The nutrient artery derived from suprascapular artery, lies at clavicle lateral to laterally directed subclavian groove[6]and in clavicle the nutrient foramen through which the artery passes is present at the junction of middle and lateral third of clavicle[7].In long bones, the location and number of nutrient foramina remains a nonconstant feature[8]. A nutrient foramen of clavicle is found in the lateral end of the subclavian groove running in lateral direction[9]. In contrast, it was reported in a study that clavicle is supplied only by periosteal arteries and the nutrient artery is not found.[10] On the other hand, the nutrient foramina of the clavicle are clinically important. These are involved in the repair of clavicular fracture, that produces neurovascular complication like supraclavicular nerve entrapment syndrome and brachial plexus injury. The conventional view was that the majority of clavicular fractures cure with good functional outcomes. The nonoperative treatment is no longer valid. Recent researchers have identified a higher rate of nonunion and specific deficits of shoulder function in subgroups of patients with these injuries[11]. Therefore, orthopedic procedures like nail plating, K wire fixation and more recently microsurgical vascularized bone transplantation are very popular. In surgical procedures like bone grafting and in microsurgical vascularized bone transplantation, the knowledge of nutrient foramen is very essential. Now a days, these techniques are very popular. The information relating to the anatomical description of these foramina is of vital importance to preserve the circulation of affected bony structure. It is also relevant for the orthopedician who are involved in surgical procedure where patency of arterial supply is crucial and it should be preserved to support fracture repair[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

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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].

Materials & methods

Study Area: This study was conducted in department of Anatomy CIMS Medical college, Bilaspur, Chattisgarh.

Study Population: In this study we included total 60 dried human clavicle bones.

Study Duration: The duration of study was over a period of one year.

Data Collection: Bones which were damaged, deformed and had gross pathological abnormality were excluded from the study. All the clavicles were observed for the number, position, location and direction of nutrient foramina.

Data Analysis: Data was analysed by using Microsoft excel.

Results

In the present study we included 60 dried human clavicle bones, which were macroscopically observed. We found that in 65% bone one foramen was present. While two nutrient foramen were present in 26.7% clavicle bones &three nutrient foramen in 8.4% clavicle bones. The present study observed that 72.1% nutrient foramen were present on the inferior surface, 26.7% nutrient foramen were present on posterior surface & 1.16% were present on superior surface.11.7% nutrient foramen were present at medial 1/3rd ,66.7% at middle 1/3rd& 21.7% at lateral 1/3rd.

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

Number of nutrient foramina	Right (30)	Left (30)	Total (60)
1	20(66.7%)	19(63.4%)	39(65%)
2	7(23.4%)	9(30%)	16(26.7%)
3	3(10%)	2(6.7%)	5(8.4%)

Table 2: Position of foramen in clavicle

Surface	Right	Left	Total
Inferior	32 (71.2%)	30(73.1%)	62(72.1%)
Posterior	12(26.7%)	11(26.8%)	23(26.7%)
Superior	1(2.3%)	0(0%)	1(1.16%)

Table 3: Distribution according to nutrient foramen of clavicle

	Right	Left	Total
Medial 1/3rd	3(10%)	4(13.4%)	7(11.7%)
Middle 1/3rd	21(70%)	19(63.4%)	40(66.7%)
Lateral 1/3rd	6(20%)	7(23.4%)	13(21.7%)

Discussion

The major source of blood supply to the bones is nutrient arteries. The clavicle bones generally have one nutrient foramen. It is present on the shaft for the passage of main nutrient artery.The clavicle has no medullary cavity. It consists of spongy bone with a shell of compact bone. Therefore, it does not depend on a nutrient artery. One or two main diaphyseal nutrient arteries enter the shaft obliquely through nutrient foramina. It leads into nutrient canal. Their site of entry and angulation are usually constant and characteristically directed away from the dominant growing epiphysis[16].The present study followed the general rule of growing end theory that the direction of the nutrient foramen is away from the growing end. The first man who correlated the direction of nutrient foramen with the ossification and growth of the bone was Bernard[17].The clavicle is a curved long bone placed horizontally at the root of neck. It holds the upper limb far from trunk so that it can move freely[20] and transmits the weight of upper limb to axial skeleton. The clavicle has a cylindrical shaft as well as two ends, sternal (medial) and acromial (lateral). As lateral one third of shaft is flattened so it has two surfaces superior and inferior and two borders anterior, and posterior. Medial two third of shaft is cylindrical and has four surfaces- anterior, posterior, superior and inferior. Inferior surface of the shaft of clavicle has subclavian groove. The nutrient foramen generally lies lateral to the subclavian groove which is directed laterally[21]. The nutrient artery of clavicle is derived from suprascapular artery[6].Nutrient artery is the major source of blood supply to long bone during its active growth. In all bones, the direction of nutrient foramen of all bones is away from growing end[22]. Lutken found that the position of that foramen can be determined by the proper study on human bone[23].In surgical and orthopedical procedures, the knowledge of position, direction and number of nutrient foramen is very important[24].Arterial supply must be preserved for proper repair of fracture and survival of osteocyte and osteoblast[25]. The major objective of this study was to determine the variation of position, direction and number of nutrient foramen in the clavicle and their clinical importance.The findings of the present study showed that 65% of clavicle had one nutrient foramen, 26.7% of clavicle had two foramen and 8.4% of clavicle had three nutrient foramina. Similar findings were found by Malukar et al and Ruchi ratnesh et al[26].In contrast other study done by Rahul rai et al found that one nutrient foramen was in 42.5%, two foramina in 52.5% and three foramina in 5% of clavicle. In this study the nutrient foramen was predominant on inferior surface (72.1%). These findings were supported by the studies done by Malukar et al[27] (56.3%) and Rahul rai et al[17] (64.6%). Whereas Ruchi Ratnesh et al showed that predominant position of nutrient foramen on inferior surface was (72.9%). The location of nutrient foramen is maximum in middle one third (66.7%) in this study. Similar findings were found by Rahul Rai et al (73.8%).Results also showed that the average distance of nutrient foramen from sternal end was found to be 69.63 mm and foramen index was 52.25. Rahul Rai et al[17]also found the average distance of foramen from sternal end was 67.6 mm and foramen index 48.01. Santosh k sahu et al[28] revealed in their study that average distance of foramen from sternal end was 65.8 mm and foramen index 52.06.

Conclusion

It can be concluded that clavicle display one nutrient foramen that was predominant on the inferior surface. The location of nutrient foramen was maximum in middle one third followed by lateral one third and then medial one third of bone length. The direction of nutrient foramen was towards acromial end. The findings of this study can be used to preserve the arterial supply during surgical procedure like internal fixation and vascularised bone graft.

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