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Original Research Article

Morphometric and Topographic Investigation of Nutrient Foramen in the Human Clavicle in North India

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Abstract

Objective: The main blood supply to a long bone comes from the nutrient artery, which enters the bone shaft through the nutrient foramen. This is especially true throughout a long bone's growth phase in the embryo and fetus as well as during the early stages of ossification in childhood. Recent research has demonstrated that the blood supply of bone has a significant impact on the lifespan of vascularized bone and joint allografts. The objective of this research was to examine the nutritional foramen in 102 adult humans of North Indian origin.

Method: At Department of Anatomy, DRIEMS Institute of Health Science & Hospital, Cuttack from June 2021 to July 2022, the study was conducted. Foramina Index was used to calculate how many and where each nutrient foramen was distributed along the length of each bone. It was also noted the nutrient canal's direction.

Results: The study revealed that 71% of clavicles had a single nutrition foramen, 21% had double foramen, and 8% had more than two foramen. 31% of clavicles had foramen on the posterior surface, compared to 69.7% that had foramen across the inferior surface. With 61.0% of dominant foramen situated in the middle third of the bone length, the foramina index range for dominant foramen was between 31% and 76.3%.

Conclusion: The acromial end was the target of the nutrition channel.

Keywords: Foramen, Nutrients, Clavicle.

Introduction

The Clavicle is a modified long bone positioned subcutaneously and horizontally at the base of the neck. Moreover, it transfers weight from the upper extremity to the axial skeleton. A subclavian groove is visible on the clavicle's inferior surface. At the lateral end of the groove that runs in a lateral direction, there is a nutrient foramen [Figure 1] [1]

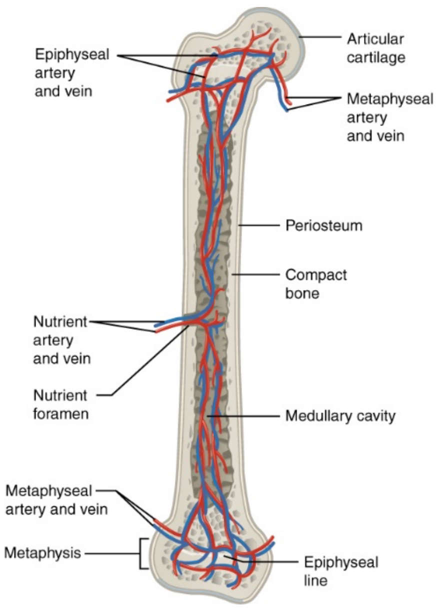

Figure 1: Nutrient canal

Blood arteries and peripheral nerves can flow through the cortex and into the medullary cavity of a bone through these nutrition foramina. The bones begin to acclimatise to the presence of nutrition foramen, which are naturally occurring holes, at foetal age. Long bones continue to have variable nutrition foramina distribution and number [2].

The lateral end of the subclavian groove, which runs in a lateral direction, contains a nutrient foramen of the clavicle. The supraclavicular nerve and the nutritive artery are occasionally transmitted through this foramen [3]. In contrast, one study claimed that the nutritional artery was not present and that the clavicle is only nourished by periosteal arteries. [4] Yet, because they are engaged in the treatment of clavicular fractures, which result in brachial plexus injury and supraclavicular nerve entrapment syndrome, the nutritional foramina of the clavicle are clinically significant. The conventional belief that the vast majority of clavicular fractures heal without surgery and with satisfactory functional outcomes is no longer true.

In subsets of individuals with similar injuries, recent studies have found a greater prevalence of nonunion and specific abnormalities in shoulder function [5]. As a result, orthopaedic techniques including K wire fixation, microsurgical vascularized bone transplantation, and nail plating are becoming more and more common. In surgical treatments like bone grafting and, more recently, microsurgical vascularized bone transplantation, understanding of nutritional foramen is crucial. Information on the anatomical description of these foramina is crucial to maintaining the circulation of the afflicted bony structure as these procedures gain popularity. It is also pertinent to orthopedic surgeons who perform procedures where maintaining arterial supply patency is essential for promoting fracture repair [6].

A healthy blood supply is essential for osteoblast and osteocyte cell survival, as well as promoting graft healing in the recipient, during free vascular bone grafting. This blood supply must be maintained to facilitate fracture repair [7].

This study was done to investigate the morphometry and topography of the nutrient foramen in the clavicle because knowledge of the anatomical description of the nutrient foramen of the clavicle is crucial to maintaining the circulation of the damaged bony structure.

Methods

Study Design: This study involved 102 (51 right and 51 left) adult human Clavicles that were washed and dried in the Department of Anatomy, DRIEMS Institute of Health Science & Hospital, Cuttack.

Methodology

The following observations were made with the assistance of a magnifying glass, a bone osteometric, a sliding vernier caliper, a digital watch, a 0.23 hypodermic needle, and guide wires (0.55 mm in diameter).

1. The number of nutrient foramina. Using a hand lens, nutrient foramina were seen in all bones. These might be recognized by their raised margins and by the presence of a clear groove close by. On the diaphysis, only clearly defined foramina were approved. Bone foramina at the ends were disregarded.
2. Location of Nutrient Foramina: A direct examination of all the foramen revealed that they were distributed over various surfaces.
3. Position of Nutrient Foramina: When computing a Foramen index (FI) using Hughes' formula, the location of only the Dominant Foramina (admitting 0.23 size hypodermic needle) was taken into consideration.
4. Direction and Obliquity: The direction and obliquity of the foramen were verified using a fine, strong wire.

Statistical Analysis: The Statistical Package of Social Sciences (SPSS) 8.0 windows were used to tabulate and analyze the results. Foramina Indices (FI) range, mean, and standard deviation was calculated.

Ethical consideration: The ethical committee of DRIEMS Institute of Health Science & Hospital after written consent was obtained from the individuals.

Results

The number of Nutrient Foramina:

On the right side, 71% of the clavicle had a single foramen, 21% had a double foramen, and 8% had more than two foramina. On the left side, 73% of clavicles had a single foramen, 21% had two, and 5% had three or more foramina. The right and left sides did not significantly differ from one another.

Position of Nutritional Foramen:

On the right side, 21 (28.4%) nutrient foramina were on the posterior side, compared to 51 (71.3%) on the inferior side. Similar to the right side, 20 (31.8%) nutritional foramen were on the back side, whereas 47 (65.17%) were on the inferior side. The right and left sides did not significantly differ from one another. P value >0.04

Nutrient Foramen Location:

On the right side, the foramina index ranged from 30.3 to 76.3, with a mean value of 61.02±9.54. The foramina index on the left side ranged from 30.1 to 75.6, with a mean value of 59.40±10.91. The result was not significant because the 't-test value for comparing the two sides was 0.77 and the p-value > 0.04.

All of the nutritional foramina that were seen on both sides pointed in the direction of the acromial end, and they were all ubiquitous (Table- 1).

Table 1: observations on the topography and morphology of the nutritive foramen in the clavicle.

Criteria	Right (n=51)	Left (n=51%)
No. of Foramina		
0	-	-
1	71%	73%
2	21%	21%

>3	8%	6%
P value >0.04, not significant		
Position of nutrient Foramen		
Inferior surface	71.3%	68.17%
Posterior surface	28.4%	31.7%
Superior surface	-	-
P value >0.04, not significant		
Location of Formina Index		
Type I	11%	10.3%
Type II	59.1%	62.4%
Type III	31.3%	27.0%
P value >0.04, not significant		
Direction of nutrient Canal	Towards acromial end	Towards acromial end

Discussion

The largest foramen on a long bone's shaft that allows nutritional arteries to enter the bone is known as the nutrient foramen, and it plays a crucial role in the growth and nourishment of long bones. As with all wounds, blood flow is necessary for fracture healing [8]. An important risk factor for improper union may be injury to the nutritional artery at the moment of the fracture or during later procedures [9]. An improvement in the management of this issue would be possible if surgeons could avoid a specific region of the long bone's cortex that contains the nutritional foramen, especially during an open reduction.

Recent findings supported the idea that the blood supply of bone is crucial for the survival of vascularized bone and joint allografts. Anatomical causes were thought to be behind this anomaly. Hence, understanding the anatomy of the nutrient foramina is crucial for orthopaedic surgeons performing open reduction of fracture in order to prevent damaging the nutrient artery and thereby reduce the likelihood of a delayed or non-union of the fracture [10].

Long bones often receive their primary blood supply at specific locations along the shaft, which affects how many nutrition foramina there are. The mean value for the right and left sides (n=102 clavicles) was compared with previous research because the study's right and left sides did not show any discernible differences. In the current study, it was found that 71% of the clavicle had a single nutritional foramen and 21% of the bone had a double foramen, which is consistent with earlier findings [11], however in another study, only 41% of the bone had a single foramen and 52.4% of the bone had a double foramen [11]. This study found that 15% of clavicles had more than two foramina, which is consistent with earlier work [12]. In this investigation, there were no clavicles that appeared to lack nutritional foramina [12]. The results suggest that the clavicle's shaft typically contains just one important canal that transmits the bone's primary nutrition artery.

The growth rates at the two ends of the shaft and bone remodelling are two well-known characteristics that may determine where the nutrition foramen is located. In some surgical techniques to maintain the circulation, topographical knowledge of these foramina is helpful. The inferior surface of the clavicle is the main position for nutritional foramen in this study, with 69.7% of foramen located there, in contrast to previous studies on the clavicle that suggested the posterior surface as the primary position for foramen [13], but in line with Grays' anatomy [1].

Unlike another study, which claimed 13% of foramen on this surface [14], the current investigation identified no foramen on the superior surface, which is consistent with findings [11].

In both orthopaedic and plastic and reconstructive surgery, proper knowledge of the location of the nutrient foramina in long bones would aid to prevent intraoperative damage. For all of these surgical operations, preoperative planning is essential, along with an accurate understanding of the extraosseous vascular supply, to ensure a positive outcome. Placing internal fixation devices correctly depends on understanding the changes in the nutritional foramen. During growth, the nutritional canal, via which the nutritious artery enters the shaft, normally becomes slanted, with the direction of the slant from the surface to the marrow cavity pointing in the direction of the end that has grown slowlyest. The faster growing end's larger longitudinal growth is the cause of this. While miniature long bones only have one developing end, all long bones, including the clavicle, have two epiphysial ends. In their sudy of 100 clavicles, the direction of each bone's nutrition foramen was away from the growing end [14].

The canal ultimately directed away from the growing end, according to a writer who studied the obliquity and orientation of nutrition canals [15]. Similar to this, according to another source, the nutritive foramen in the clavicle was pointed in the direction of the acromial end [16,17].

Conclusion

It was determined from the current study, which was based on observations of the morphology and topography of the diaphysial nutrient foramen in human clavicles, that clavicles typically only had one nutrient foramen, which was primarily located on the inferior surface. The middle third of the bone's length had the highest concentration of nutritional foramina, followed by the proximal third and the distal third with the lowest probability. On the right side of the clavicle, the mean foramina index was 61.02 ±9.54, and on the left, it was 59.40 ± 10.91. The sternoclavicular end served as the growing end because the nutrient foramen was oriented towards the acromial end. On both the right and left sides, the nutritional foramen had comparable architecture and topography. The current study will be useful for maintaining the clavicle's blood supply while undergoing surgical operations such coracoclavicular ligament repair, internal fixation, and microvascular bone grafting.

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