Original Article

A study of the Nutrient Foramina in the Humeri, the Long Bones, and Their Significance for Surgery

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Abstract

Background: For orthopaedic surgical operations like joint replacement therapy, fracture repair, and bone transplants to be successful, the anatomical location and distribution of nutrition foramina are essential. The current study aimed to investigate the surgical importance of the human humeri's diaphyseal feeding foramina. The quantity, location, dimensions, and orientation of each bone's nutrition foramina were examined. **Material and Methods:** 120 human humeri were cleaned and dried for the current investigation, and standard anthropometric tools and methods were used for all measurements. The bones that were chosen were all normal and showed no signs of pathological alterations; They were all removed from the Nims Medical College's Department of Anatomy in Jaipur, Rajasthan. The precise age and sex of the bones being studied were unknown. **Results:** In all of the bones analyzed, the majority of the nutrition foramina were solitary and secondary in size., with very few exceptions. The majority of nutrient foramina were found on the anterior side of the bone shaft and in the middle third of the bone. Their orientation was in accordance with the growing end idea. **Conclusion:** In summary, the current study's findings supported earlier research on the quantity and location of nutritional foramina and offered clinical data on them that may be helpful as a guide for future operations.

Keywords: Fracture, Bone Graft, Humerus Nutrient foramen, Nutrient artery.

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Introduction

Peripheral nerves and nutritional arteries are conducted through cavities called nutrient foramina or canals. The nutritive arteries are the primary source of blood flow for long bones, primarily throughout the growth and early stages of ossification.[1]

During childhood, the nutritional arteries provide around 80% of the interosseous blood supply to long bones; if these arteries are absent, vascularization takes place through the periosteal vessels.[2]

The nutrient canal, which allows the nutritional artery to enter the shaft during growth —usually becomes slanted; The end that has grown the slowest is indicated by the slope's direction from the surface to the marrow cavity. This is because the faster developing end has more longitudinal growth.

Every bone's nutrition foramen faces away from the growing end. Nutrient foramen is important for treating fractures, especially in bone grafts, the blood flow of nutrients is vital and should be maintained to encourage fracture healing.[3] Furthermore, the survival of the osteocytes in situations including tumour excision, trauma, and congenital pseudo-arthrosis depends on the availability of intact nutritional blood flow.[4]

The professional can choose the receptor's levels in the osseous portion during transplant operations by using statistical data on the distribution of nutrient foramina in long bones. This allows the graft to be placed without causing damage to the nutrient arteries, maintaining the diaphyseal vascularization and transplant consolidation.[5]

Understanding where the nutrition foramina are located may help avoid vascular injury during surgery that might otherwise result in a shortage of blood flow to the bones.

In orthopaedic surgical treatments such joint replacement therapy, fracture repair, bone grafts, and vascularised bone microsurgery, as well as in medicolegal issues, it is crucial to know the position and quantity of nutrition foramina in long bones.[2]

The location and amount of the humeri's nutrition foramina, however, still require further investigation.

The aim of the present study is: to ascertain the quantity, various locations, dimensions, and orientation of nutritional foramina in the human humeral shaft.

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Materials and Methods

Material Use: One hundred and twenty dried human humeri, surgical needles, a magnifying glass, a digital camera, a permanent marker, Sprite, cotton, colored rubber bands, white tape, and an osteometric board.

Methods: 120 adult individuals' cleansed and dried bones made up the study's material. They were acquired from Nims Medical College in Jaipur's Department of Anatomy.

There were no visible pathological alterations in any of the chosen bones. The precise age and sex of the bones being studied were unknown.

All of the bones were labelled with numbers ranging from 01 to 120 using a permanent marker after being cleansed with a sprit swab to remove any dust particles and nutrient foramina obstructions.

Using a hand lens, the nutrient foramina were visible in every bone. They were distinguished by having high edges and a characteristic groove close to them. Only distinct diaphytic foramina were approved. If the 24 hypodermic needle was inserted correctly, it was regarded as a dominant foramina; if not, it was regarded as a secondary foramina. The rubber band was tied close to the nutrient foramina, and the foramina at the ends of the bones were disregarded in order to determine the size of the insert.

Data analysis: The following information was used to analyze each bone's diaphyseal nutrition foramina:

1. Number: Using a hand lens, the number of nutritional foramina in the bones was assessed.

2. Position: Calculation of the foraminal index:

The formula FI = (DNF/TL) x 100 6,7 was used to calculate a foraminal index (FI), which indicated the location of each nutrient foramina.

The distance between the nutrient foramen and the proximal end of the bone is known as DNF.

TL stands for total length of bone

Calculations the overall length of the humerus: the separation between the most distal part of the trochlea and the proximal border of the humeral head.

Foramina position subdivisions based on the Foramina index: FI classified the foramina's positions into three categories, which are as follows:

Type 1: FI up to 33.33, the foramen was in the proximal third of the bone.

Type 2: FI from 33.33 up to 66.66, the foramen was in the middle third of the bone.

Type 3: The foramen was located in the distal portion of the bone at FI greater than 66.66.

Size: Nutrient foramina were classified as secondary foramina (S.F.) if they were smaller than 24 hypodermic needles (0.55 x 25 mm in diameter), and as dominant foramina (D.F.) if they were equal or greater.

Direction: The foramen's orientation was verified using a thin, strong wire.

Photographs: Photographs were taken by a Sony digital camera (16.1mega pixels). Each photograph had a definition of 16x12 cm.

Statistical analysis: The Statistical Package of Social Sciences (SPSS) 8.0 was used to analyse and tabulate the data. The FI's mean, standard deviation, and range were calculated.

T-Test on position of Nutrient Foramen

An independent sample t-test is conducted using SPSS-16 to ascertain the location of the nutrient foramen (as established in the study) in each of the study sample's bones. Less than 0.05 is the consistently low significant value, according to the data. This demonstrates that for the study's sample, there was a significant difference between the population mean and the nutrient foramen site mean values.

Results

Number: Twelve (10%) of the 120 humeri exhibited double foramina, while 108 (90%) had a single foramen.

Position: With a foramen index ranging from 33 to 66, the central portion of the humerus had the greatest number of nutrient foramina. The middle third (Type-2) contained 108 (81.81%) of the 132 dominant nutritional foramina, while the distal third (Type-3) contained 24 (18.18%).

Direction: All of the humeri under examination had nutritional foramina pointing distally.

Site: Out of the 148 nutritional foramina (132 dominants and 16 secondary), 116 (78.37%) were on the antero medial surface, where 108 were dominant and 8 were secondary, and 24 (16.21%) were on the medial surface, where 16 were dominant and 8 were secondary, all eight (5.40%) were prominent and situated at the medial boundary on the posterior surface.

Size: 132 (89.18%) of the 148 foramina were dominant, whereas 16 (10.81%) were secondary.

Table 1: Distribution of nutrient foramina in the long bones of upper limb.

Bone	Number Of Bone	Numer Of Foramina	Percentage
Humerus (N=120)	108	Single	90.00%

Table 2: Position and direction of dominant nutrient foramina in long bones of upper limb.

BONE	POSITION			DIRECTION
	TYPE-1	TYPE-2	TYPE-3	
HUMERUS	0	108 (81.81%)	24 (18.18%)	Distally

Table 3: Site and number of dominant (DF) and secondary (SF) nutrient foramina in humerus

Position	Total number	Percentage	Number of foramina			
			Single		Double	
			DF	SF	DF	SF
Antero Medial Surface	116	78.37%	100	08	08	-
Posterior Surface (in middle of surface)	24	16.21%	16	08	-	-
Posterior surface (Close to Medial Border)	08	5.40%	08	-	-	-

Figure 1: A photographs of osteometric board

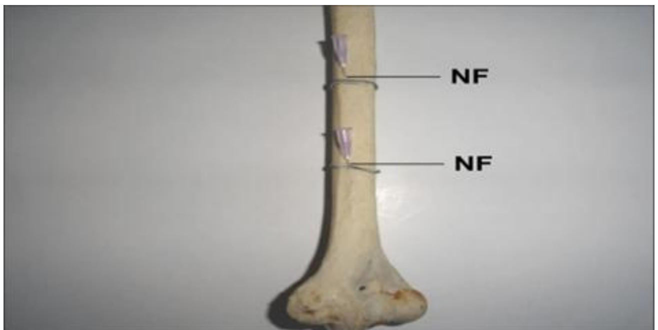

Figure 2: A photographs of Humerus, anterior surface showing double nutrient foramen on the anteromedial surface of Shaft, The Foramen is located in middle 1/3rd (Type-2) and Distal 1/3rd (Type -3) and directed distally (downwards).

Figure 3: A photograph of Humerus, posterior surface showing single nutrient foramen on the posterior surface of Shaft, The Foramen is located in middle 1/3rd (Type-2) and Distal 1/3rd (Type -3) and directed distally (downwards)

Discussion

Humerus's Nutrient Foramina count: In the humeral bones in the current study, the percentage of a single nutrient foramen is higher (90%) than that of a double (10%). Similar percentages to the current result were observed in a number of research (Longia,[3] 1980 (92.5%) Lutken,[8] 1950 (76.3%); Vinay,[9] 2011 (92.5%); Pereira,[10] 2011 (88.5%); Skawina A (1994).[11]

According to several research, the percentage of single nutrient foramina ranged from 53% to 76% (Mysorekar,[12] 1967, 58%, Forriol Campos et al 1987, 75%).[13]

Hemang Joshi 2011 (63%), Carroll 1963 (67.63%), and Bridgeman 1996 at 53.2%.[14-16]

The percentage of triple foramina occurrence in the humeri was determined by Kizilkanat (2007),[17] while the range of double foramina incidence was 8%–42%. While four nutritional foramina were found in 1% of the humeri evaluated by Kizilkanat et al (2007),[17] triple foramina were not seen in the current study. In this investigation, such a number was not detected.

However, other authors (Lutken,[8] 1950; Patake et al,[18] 1977; Longia et al,[3] 1980; Kizilkanat et al,[17] 2007) also reported the lack of nutrient foramina in some humeri, stating that in these cases, the periosteal vessels were solely responsible for the blood supply of the bone.

Position of Nutrient Foramina in humerus: The middle part of the humerus included 81.81% of the humeral nutritional foramina in this study, while the proximal third contained 18.18%. The foramen index ranged from 46 to 75.

According to earlier research, the nutrition foramina are located in the middle part of the bone, which fits with the current findings (Carroll,[14] 1963; Kizilkanat et al,[17] 2007; Nagel,[19] 1993; Forriol Campos et al,[13] 1987; Longia et al,[3] 1980; Mysorekar,[12] 1967).

The anteromedial surface of the bone contained 78.37% of all humeral nutrition foramina in this study. Similar results (60%–70%) were reported by Kizilkanat et al,[17] (2007), Longia et al,[3] (1980), Carroll (1963),[14] and Forriol Campos et al,[13] (1987). This is in contrast to Mysorekar (1967),[12] who found an equal percentage of foramina on the medial border and the anteromedial surface. This kind of distribution is not evident in the current investigation.

Size of Nutrient Foramina: The current findings demonstrated that dominant foramina were more prevalent than secondary foramina in the humerus, which had both types of foramina. the bulk of the nutritional foramina in all humeri were secondary, which was also consistent with findings by Carroll,[14] (1963) and Longia et al,[3] (1980) He discovered that over two-thirds of the foramina of nutrients were secondary. Kizilkanat et al,[17] (2007) reported that a single nutrient foramen was consistently in the lead whenever it was observed. In the current investigation, this was not seen. According to Sendemir and Cimen (1991),[20] a humerus cannot exist without a dominating nutrition foramen. This assertion also applied to the current investigation.

Nutrient Foramina Direction: The humerus's nutritional foramina were all oriented distally, or away from the growing ends, for the purposes of this study. Lutken8 (1950) reported similar results, stating that all of the humerus's channels were oriented distally.

Conclusion

Regarding the quantity, location, size, and orientation of the nutritional foramina in the numerus, the study supported earlier findings. Important details regarding the clinical relevance of nutrient foramina were also supplied.

Therefore, it is advised that orthopaedic surgeons have a thorough awareness of the anatomical properties of the nutritional foramina. In order to prevent injury to the nutrient vessels during surgical procedures, the precise location and distribution of nutrient foramina in the bone diaphysis are crucial.

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Conflicts of interest

There are no conflicts of interest.

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