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RESEARCH ARTICLE

A STUDY OF NUTRIENT FORAMINA IN THE LONG BONES HUMERI AND ITS SURGICAL IMPORTANCE

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ABSTRACT

Background: The anatomical position and distribution of nutrient foramina is necessary for the success of orthopedics surgical procedures such as joint replacement therapy, fracture repair and bone grafts.

Aims and objectives: The aim of the present study was to study the diaphyseal nutrient foramina in human humeri and its surgical importance's. for each bone, the number, position, size, and direction of their nutrient foramina were studied.

Material and Methods: The present study was conducted on 120 human cleaned and dried humeri and all measurements were done by using standard anthropometric instruments and techniques. All bones were obtained from the Department of anatomy, Nims medical collage Jaipur, Rajasthan and the selected bones were normal with no appearance of pathological changes. The specific age and sex characteristics of the bones studied were unknown.

Observation and Results: With few exceptions the majority of nutrient foramina in all bones studied were single in number and were secondary in size. Most of the nutrient foramina were concentrated in the middle third of the bone and located on the anterior surface of the shaft of bones and the direction of nutrient foramina followed the growing end theory.

Conclusion: The results of the present study confirmed previous findings regarding the number and position of nutrient foramina and provided clinical information concerning the nutrient foramina which could be useful as reference for surgical procedures.

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INTRODUCTION

The nutrient foramina or canal are cavities that conduct the nutrient arteries and the peripheral nerves. The major blood supply for long bones originates from the nutrient arteries, mainly during the growing period and during the early phases of ossification (Lewis, 1956). During childhood, long bones receive about 80% of the interosseous blood supply from the nutrient arteries and in the case of their absence, the vascularization occurs through the periosteal vessels (Trueta, 1953). Nutrient canal (through which nutrient artery enters the shaft) typically become slanted during growth the direction of slant from surface to marrow cavity points towards the end that has grown least rapidly. This is due to greater longitudinal growth at the faster growing end. The direction of nutrient foramen of all bones is away from growing end. Importance of nutrient foramen is relevant to fracture treatment and in bone grafts, the nutrient blood supply is crucial and it should be preserved in order to promote the fracture healing (Longia1980) Moreover, the presence of preserved nutrient blood flow is essential for the survival of the osteocytes in cases of tumor resection, traumas, and congenital pseudoarthrosis (Gümüsburu 1994). In transplant techniques, the use of statistical data on the nutrient foramina distribution in long bones makes it possible for the professional to select the osseous section levels of the receptor in order to place the graft without damaging the nutrient arteries, preserving, thus, the diaphyseal vascularization and the transplant consolidation (Wavreille 2006). The knowledge of the locations of nutrient foramina may be helpful in preventing lack of blood supply of the bones due to vascular damage during surgical procedures of these areas. (Taylor1979). An understanding of the location and number of nutrient foramina in long bones is, therefore important in orthopedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery, as well as in medicolegal cases (Trueta, 1974). In free vascular bone grafting, the

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nutrient blood supply is extremely important and must be preserved to promote fracture repair, with a good blood supply being necessary for osteoblast and osteocyte cell survival, as well as facilitating graft bone grafts and vascularized bone microsurgery, as well as in medicolegal cases (Gumusburun, 1994). However, there is still a need for a greater understanding of the location and number of nutrient foramina in the humeri. The aim of the present study is: To determination of the number, different position, size and the direction of nutrient foramina in the shaft of human humeri.

MATERIAL AND METHODS

Material Use: 120dried human humeri, magnifying glass, surgical needles, osteometric board, digital camera, Permanent marker, sprite, white tape, cotton and color rubbers bands.

Methods: The material of the present study consisted of 120 adult human cleaned and dried bones They were obtained from the Department of Anatomy, Nims medical collage Jaipur. All selected bones were normal with no appearance of pathological changes. The specific age and sex characteristics of the bones studied were unknown. All the bones were cleaned with sprit swab to removing of any kind of blockages of nutrient foramina and dust particles on the bone and labeled the bones by numbers of 01 to 120 of each with permanent marker. The nutrient foramina were observed in all bones with the help of a hand lens. They were identified by their elevated margins and by the presence of a distinct groove proximal to them. only well-defined foramina on the diaphysis were accepted. To determine the size insert, the needle of 24 hypodermic size in the nutrient foramina if it insert properly was considered as a dominate foramina if not then was considered as secondary foramina and bind the rubber band near the nutrient foramina and the foramina at the ends of the bones were ignored.

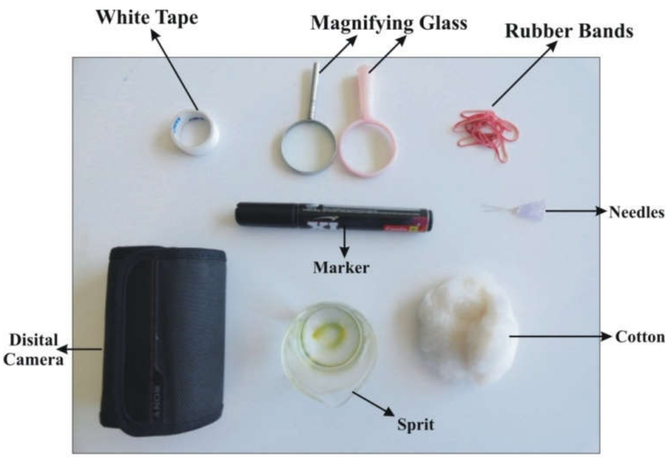

Figure 1. A photographs of Material used during study of nutrient foramina

Data analysis: The following data were studied on the diaphyseal nutrient foramina of each bone:

Number: Bones were examined for the number of nutrient foramina by help of hand lens.

Position

Calculation of the foraminal index: The position of all nutrient foramina was determined by calculating a foraminal index (FI) using the formula:

FI = (DNF/TL) x 100 (Hughes, 1952; Shulman, 1959).

DNF = The distance from the proximal end of the bone to the nutrient foramen.

TL = Total bone length.

Determination of the total length of humerus: The distance between the proximal margin of the head of the humerus and the most distal aspect of trochlea.

Figure 2. A photographs of osteometric board

Subdivisions of position of foramina according to Foramina index

The position of the foramina was divided into three types according to FI as follow:

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: FI above 66.66 the foramen was in the distal third of the bone

Size

The Nutrient foramina smaller than the size of 24 hypodermic needles (0.55x25mm in diameter) Were considered as being secondary foramina (S.F) while those equal or larger were accepted as being dominant foramina (D.F).

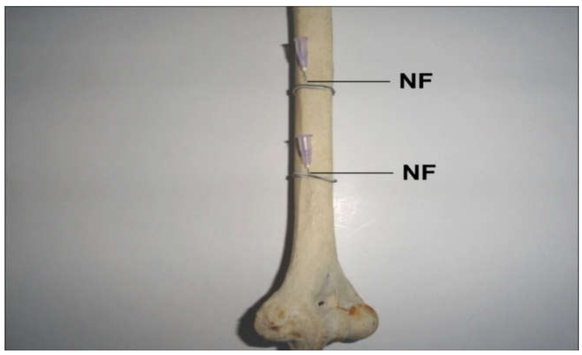

Figure 3. A photographs of Humerus, anterior surface showing double nutrient foramen on the anteromedial surface of Shaft, The Foramen is located in middle 1/3rd (Type-2) and Distal 1/3rd (Type -3) and directed distally (downwards)

Direction: A fine stiff wire was used to confirm the direction of the foramen.

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

Figure 4. A photographs 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)

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

Bone	Number of Bone	Number of Foramina	Persentage
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	-	-	-

Statistical analysis

The results were analyzed and tabulated using the Statistical Package of Social Sciences (SPSS) 8.0 windows. The range, mean and standard deviation of FI were determined.

T-Test on position of Nutrient Foramen

An Independent sample t-test is conducted with the help of SPSS-16 for the position of nutrient foramen (as found in the study) in all the bones considered in the sample for study and result shows that in all the cases the significance value is very less (less than 0.05). This shows that the mean values of the position of nutrient foramen for the sample considered for the study are significantly different from that of the population mean.

RESULTS

Number: Out of 120 humeri 108(90%) had a single foramen and 12 (10%) had double foramina.

Position

The maximum nutrient foramina were located along the middle third of the humerus with the foramen index ranging between 33 and 66. There were total 132dominant nutrientforamina out of them 108(81.81%) were located in the middle third (Type-2) and 24 (18.18%) were in the distal third (Type-3).

Direction: The nutrient foramina in all humeri examined were directed distally.

Site: there were total 148 (132 dominants and 16secondary) nutrient foramina, out of them 116 (78.37%) were on the antero medial surface in which 108 were dominant and 8 were secondary and 24 (16.21%) were located on the medial surface in which 16 were dominant and 8 were secondary,8 (5.40%) were located on the posterior surface close to the medial border and all were dominant.

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

DISCUSSION

Number of Nutrient Foramina in Humerus: In the present study, a single nutrient foramen has a higher percentage (90%) in the humeral bones, compared to that of double (10 %).Many studies reported a percentage approximately similar to that of the present result (Longia *et al*.,1980 (92.5%) Lutken, 1950 (76.3%) B.V.Morianju 2011(93.6%); Vinay *et al*, 2011(92.5%) Perira 2011(88.5%) A.skawina (1994). Some studies reported a lower percentage of single nutrient foramina (53%-76%) (Mysorekar, 1967(58%), Forriol Campos *et al*.1987 (75%) Carroll, 1963(67.63%) S.Samarian2011 (60%), himangjoshi 2011(63%), Bridemen 1996 (53.2%). The range of occurrence of double foramina varied from 8%-42% and according to Kizilkanat (2007), the percentage of occurrence of triple foramina in the humeri was found. But in present study triple foramina was not present, Moreover, Kizilkanat *et al*. (2007) reported the presence of four nutrient foramina in 1% of the humeri studied. Such number was not observed in the present study. On the other hand, the absence of nutrient foramina in some humeri was also reported by other authors (Lutken, 1950; Patake *et al*., 1977; Longia *et al*., 1980; Kizilkanat *et al*., 2007) they stated that in such cases, the periosteal vessels were entirely responsible for the blood supply of the bone.

Position of Nutrient Foramina in humerus: In this study 81.81% of the humeral nutrient foramina were located along the whole middle third of the humerus and 18.18% were located along the proximal third with the foramen index ranging between 46 and 75. In accordance with the present results, previous studies also reported the position of the nutrient foramina within the middle third of the bone (Carroll, 1963; Mysorekar, 1967; Longia *et al*., 1980; Forriol Campos *et al*., 1987; Nagel, 1993; Kizilkanat *et al*., 2007). In this study, 78.37% of all humeral nutrient foramina were observed on the anteromedial surface of the bone and approximately similar findings had been reported(60%-70%) by Carroll (1963), Longia *et al*. (1980), Forriol Campos *et al*. (1987) and Kizilkanat *et al*. (2007). On the other hand, Mysorekar (1967) reported an equal percentage of foramina on both the anteromedial surface and the medial border. Such type of distribution not found in present study.

Size of Nutrient Foramina: The present results showed that, humerus had dominant as well as secondary foramina but dominant foramina have higher percentage compare to secondary. All humeri possessed a majority of secondary nutrient foramina also these results were similar to Carroll (1963) and Longia *et al*. (1980) who reported that about two third of the nutrient foramina were secondary. kizilkanat *et al*. (2007) state that wherever a single nutrient foramen was observed, it was always dominant. This was not seen in the present study.Sendemir and Cimen (1991) stated that there was no humerus without a dominant nutrient foramen. Such statement was applicable in the present study also.

Direction of Nutrient Foramina: In this study, all the nutrient foramina in humerus were directed distally (away from the growing ends). Similar observations were reported by Lutken (1950) who stated that all canals which were found in humerus were directed distally.

Conclusion

The study confirmed previous reports regarding the number, position, size and direction of the nutrient foramina in the numerus. It also provided important information to the clinical significance of nutrient foramina. Accordingly, a well understanding of characteristics morphological features of the nutrient foramina by orthopedic surgeons is recommended. Exact position and distribution of nutrient foramina in bone diaphysis is important to our damage to the nutrient vessels during surgical procedures.

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