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ANATOMICAL STUDY OF NUTRIENT FORAMEN IN THE LONG BONES OF UPPER EXTREMITIES

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Abstract: **The aim of the present study is to observe number of foramina on the shaft of a bone, to observe surface on which it was located and to observe Location in relation with length of the shaft.**

This study was conducted in 80 long bones of the upper limb (40- humerus, 20 - radius, and 20-ulna). The number and position of the diaphysis nutrient foramen in each of the long bones were noted.

The result of the study shows, that in humerus single nutrient foramen was present in 85% of the bones, double nutrient foramina in 15% of the bones. The most common location of the nutrient foramina in humerus was in Antero medial surface, which was noted in 40% of the bones and in 80% of the bones the nutrient foramen was located in the middle third of the shaft of humerus. In radius, single nutrient foramen was found in 90% of the bones and double nutrient foramina were found in 10% of the bones. The most common location of the nutrient foramen in radius was on the anterior surface, which was noted in 70% of the bones and in 60% of the bones, the nutrient foramen was located in the middle third of the shaft of radius. In ulna, single nutrient foramen was found in 95% of the bones and double nutrient foramina were found in 5% of the bones. The most common location of the nutrient foramen in ulna was on the anterior surface, which was noted in 60 % of the bones and in 80% of the bones the nutrient foramen was on the middle third of the shaft of ulna.

To conclude the result we can say, that the precise anatomical knowledge of the nutrient foramen of the long bones of upper limb is important for orthopedic surgeons during surgical procedures like bone grafting, microsurgical bone transplantation.

Keywords: Nutrient Foramen, Long Bones, Variation in Position, Location, Number

I. INTRODUCTION

Nutrient foramen is an opening in the bone shaft which gives passage to the blood vessels of the medullary cavity of a bone for its nourishment and growth [1]. The nutrient artery is the principal source of blood supply to a long bone and is particularly important during its active growth period in the embryo and fetus, as well as during the early phase of ossification [2]. The nutrient artery enters individual bones obliquely through a nutrient foramen [3].Nutrient foramen is directed towards elbow in upper limb (directed towards lower end of humerus and upper ends of radius and ulna). This is said to be due to one end of limb bones growing faster than the other and generally follows the rule, "to the Their positions in mammalian bones are variable and may alter during the growth phase.

The topographical knowledge of these nutrient foramina is useful in operative procedures to preserve the circulation.[4-6] Humphrey was working on the direction and obliquity of nutrient canals postulated periosteal slipping theory, the canal finally directed away from the growing end. [7]. Nutrient artery is the major source of blood supply to the bone and hence plays an important role in fracture healing.

Orthopedic surgical procedures like vascularized bone microsurgery requires the detailed knowledge of the blood supply. In free vascular bone grafting, the blood supply by nutrient artery is extremely important and must be preserved in order to promote fracture healing [8]. Study of nutrient foramina in upper limb is very important for morphological, clinical, and pathological point of view. Fracture healing or hematogenic osteomyelitis is closely related to the vascular system of the bone. [9] Detailed data on the blood supply to the long bones is invariably crucial in the development of new transplantation and resection techniques in orthopedics [2, 10].

II. MATERIALS AND METHOD

The present study was conducted in the Department of Anatomy, Kabul University of Medical Sciences. This study was approved by the academic and Institutional research and ethics committee.

The materials for the present study consisted of 80 adult human cleaned and dried bones of the upper limbs. They were divided into three groups: 35 bones of humerus and 25 bones radius and 20 of ulna. All selected bones were normal with no appearance of pathological changes.

III. OBJECTIVES

To observe number of foramina on the shaft of a bone, to observe Surface on which it was located, to observe Location in relation with length of the shaft. 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.

IV. POSITION OF NUTRIENT FORAMINA

The distance of the dominant nutrient foramen (DNF) from the highest point of the proximal part of the long bones was measured with Vernier calipers. The total length (TL) of the bone was measured using an osteometric board. The position of all nutrient foramina was determined by calculating the foraminal index (FI) using the formula:
FI = (DNF/TL) x 100
Where DNF=the distance from the proximal end of the bone to the nutrient foramen; TL=Total bone length [11].
The position of the foramina was divided into three types according to FI as follows:

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

Table 1: Position of nutrient foramina

Bones	Position		
	Type 1	**Type 2**	**Type3**
Humerus	-	32 (80%)	8(20%)
Radius	8(40%)	12(60%)	-
Ulna	4(20%)	16(80%)	-

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. All the observations were statistically analyzed using Microsoft excel worksheet.

Results
Number of nutrient foramina observed: In humerus, single nutrient foramen was observed in 85% of the bones, double nutrient foramina were observed in 15% of the bones (Table 1).

Table 2: Number of nutrient foramina in long bones of the upper limb.

Bones	Number of foramina	Number of bones (%)
Humerus N=40	1	34(85)
	2	6 (15)
Radius N=20	1	18(90)
	2	2 (10)
Ulna N=20	1	19 (95)
	2	1 (5)

In radius, single nutrient foramen was observed in 90% of the bones and double nutrient foramina were observed in 10% of the bones (Table 1).
In ulna, single nutrient foramen was observed in 95 % of the bones, double nutrient foramina were observed in 5% of the bones (Table 1).

Table 3: Position of nutrient foramina in the humerus

Position	Number of foramina (%)
Antero medial surface	32(40)
Medial border	6(15)
Posterior surface	1(2.5)
Anterior border	1(2.5)

Nutrient foramina in humerus: 80% of the nutrient foramina were most commonly present in the middle one third of the humerus bone (Table 2).40% of the nutrient foramina were most commonly located in the anteromedial surface (Table 3).

Table 4: Position of nutrient foramina in Radius

Position	Number of foramina (%)
Anterior surface	14(70)
Medial surface	4(20)
Anterior border	1(5)
Posterior surface	1(5)

Nutrient foramina in radius: 60% of the nutrient foramina were most commonly present in the middle one third of the radius bone. (Table 2). 70% of the nutrient foramina were most commonly located in the anterior surface (Table 4)

Table 5: Position of NF in the ulna.

Position	Number of foramina (%)
Anterior surface	12(60)
Medial border	6(30)
Posterior surface	1(5)
Anterior border	1(5)

Nutrient foramina in ulna: 80 % of the nutrient foramina were most commonly present in the middle one third of the ulna bone.(Table2).60% of the nutrient foramina were most commonly located in the anterior surface (Table 5).

Discussion

Number of Nutrient Foramina: In our study, a single nutrient foramen had a higher percentage (85%) in the humeral bones, compared to that of double (15%).Many studies reported a percentage approximately similar to that of the present result [12,5].The range of occurrence of double foramina varied from 13% [13]to 26% [14] and 42% [5]. In the present study total 90% of the radius examined had a single nutrient foramen (Table 1). In other studies, the majority of radii more than 90% were found to possess a single nutrient foramen [2, 16].

The absence of nutrient foramina in the long bones is well known.[5,15,16] In the present study, we did not found any radii with the absence of the nutrient foramina.

Gotzen, N et al and Gumusburun, E et al [17,18] were noted a single nutrient foramen in more than 94% of ulnae. This corresponds with the observations in the ulnae in the present study (Table 1)

Position of Nutrient Foramina: In our study, most of nutrient foramina were located along the middle third of the humerus (Table 2) which was correlated with other studies [2,19,20] Also,40% of all humeral nutrient foramina were observed on the anteromedial surface of the bone (Table3). Similar findings had been reported by Kizilkanat et al. [2] ,Kumar et al [14],and Ukoha Ukoha Ukoha et al [21]. Mysoreker VR[5] and Caroll SE [22] in their studies stated that surgery or fracture in distal and middle 1/3 of the shaft of the humerus leads to the poor healing compared to fracture of proximal half of the bone which is unlikely to compromise the blood supply.

In our study, 60% of the total nutrient foramina were noted most often in the middle third of the radius and 40 % were in the proximal third. No nutrients foramina were detected in the distal third of radius (Table 2).The ratios of the present study were close to those reported by Mysorekar (1967) who found 62% of foramina located in the middle third of the bone and 36% in the proximal end [5]. Similar findings had been reported by Anusha P et al [23].In the present study, 70% of all radial foramina were on the anterior surface, of the bone. Such results were in accordance with the previous studies [19] who stated that the majority of nutrient foramina were located on the anterior surface of the bone. In the present study, the majority of nutrient foramina (80%) were in the middle third while 20% were in the proximal third of the ulna bone (Table 2). No nutrient foramina were detected in the distal third of the ulnae. Some authors reported that the majority of nutrient foramina were located in the middle third [5] while others stated that most of foramina were in the proximal third (13, 14). Also, 60 % of the nutrient foramina were located on the anterior surface of the ulnae (Table 5). In all previous studies, the nutrient foramina were mostly observed on the anterior surface of the ulna [2, 10].

V. CLINICAL RELEVANCE

An understanding of the position and number of the nutrient foramina in long bones is important in orthopedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts and vascularized bone microsurgery [2].

The foramen may be a potential area of weakness in some patients and, when under stress because of increased physical activity or decreased quality of the bone, the foramen may allow development of a fracture. Position of the fracture relative to the nutrient foramen of the long bone and the patterns of edema are the secondary signs in the key of the diagnosis of this type of fracture [25].

VI. CONCLUSION

The study confirmed previous reports regarding the number and position of the nutrient foramina in the long bones of the limbs.

It also provided important information to the clinical significance of the nutrient foramina. The anatomical data of this subject is enlightening to the clinician as the micro vascular bone transfer is becoming more popular.

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