Morphometric Analysis of Nutrient Foramina in Human Typical Long Bones Of Upper Limb

Dr. Ajay Mansukh bhai Parmar*, Dr. Bhadresh Vaghela, Dr. Kanan Shah***,**
Dr. Bhaskar Patel**, Dr, Bharat Trivedi*****

*Assistant Professor, Anatomy, Pacific Medical College & Hospital, Udaipur, Rajasthan, **Assistant Professor, Anatomy, GMERS Medical College, Valsad, India, ***Associate Professor, ****Assistant Professor, Anatomy, NHL Municipal Medical College, Ahmedabad. *****Professor, Narsinhbhai Patel Dental College & Hospital, visnagar

Abstracts: The major blood supply to long bones occurs through the nutrient arteries, which enter through the nutrient foramina. This supply is essential during the growing period, during the early phases of ossification, and in procedures such as bone grafts, tumor resections, traumas, congenital pseudoarthrosis, and in transplant techniques in orthopaedics. The present study analyzed the location, direction, size and the number of nutrient foramina in the diaphysis of 180 long bones of the upper limbs of adults: 60 humerus, 60 radius, 60 ulna. The location of the nutrient foramina is predominant on the anterior aspect of the upper limb long bones. The majority of the bones studied had a single nutrient foramen, which may represent a single source of blood supply. The mean foraminal index for the upper limb bones was 55.4% for the humerus, 34.7% for the radius, and 36.0% for the ulna. This study recorded data that may help in surgical procedures and in the interpretation of radiological images. [Parmar ANJIRM 2014; 5(5):26-29]

Key Words: Nutrient artery, Nutrient foramina, Long bones

Author for correspondence: Dr Ajay Parmar, Department of Anatomy, Pacific Medical College, Udaipur, Rajasthan - 313001. **MO:** +91 9824381418; **Email:** drajay9118@gmail.com

Introduction: Nutrient foramen is the largest foramen on the shaft of long bones through which nutrient artery for that bone passes. The nutrient foramina has been studied in the past by Havers, Berard, Schwalbe, Langer,Digby, Harris. Berard[1] was the first to correlate the direction of the canal with the ossification and growth of the bone. Humphrey[2] was working on the direction and obliquity of nutrient canals postulated periosteal slipping theory, the canal finally directed away from the growing end. Harris[3] has stated that the position of nutrient foramina is constant during the growth of long bone. Lutken[4] has stated that position of nutrient foramina is variable & typical position of nutrient foramina can be determined after a study on human bones. Currently, the detailed study of blood supply to long bones is a determining factor for the success of new techniques for bone transplant and resection in orthopedics (Guo[5], Kirschner[6]*et al.*).

Aims and Objective:

1. To know the number of nutrient foramina in the shaft of a particular bone.
2. To know the different position of nutrient foramina with reference to the surface of shaft long bone.
3. To know the direction of nutrient foramina with reference to the growing ends of the bone.
4. To know the size of nutrient foramina in shaft of particular bone.
5. To know the foraminal index for a particular bone.

The present study was conducted in the variability of the position of the nutrient foramina and its importance in orthopedic procedures and evaluating techniques.

Material and Method: We analyzed 180 long bones from the Anatomy Department of Smt. N.H.L. Medical College, Ahmedabad: 60humeri, 60 radii, 60 ulnae. The laterality of the bones was the only known data, and right side and left side bones were identified; data about their age and gender were notavailable. The localization, size and number of nutrient foramina were analyzed in each bone. Size of nutrient foramina measured by using size 18, 20, 22, hipodermic needle and divided into three category small, medium, large size. Foramina smaller than a size 20 hipodermic needle was considered smallforamina and foramina larger than 20 hipodermic needle were considered largeforamina. The NF distribution in the bone length was determined by calculating a

foraminal index (FI), using the formula: FI= (DNF/TL) x 100, where DNF is the distance from the proximal end of the bone to the NF, and TL is the total bone length. Determination of the total length of individual bones was taken according to Forriol[7] Campos *et al.* (1987) and Kizilkanat[8]*et al*. The measurements were taken in centimeters with the help of anthropometric caliper on osteometric board.

Figure 1: Measurement of Total Length of Bone

Results: *Humerus:* A total of 60 humeri were studied, of which 30 humeri were belonging to the left side and 30 humeriwere belonging to the right side. Total numbers of nutrient foramen were 77, of which single nutrient foramen found in 45 and double nutrient foramen found in 13 bones, three nutrient foramen found in two bones. Most of the nutrient foramen found on antero-medial surface of humerus. All the nutrient foramen directed downwards, i.e. towards elbow .Average length of humeri was 30.5(±2.02)cms and average distance of nutrient foramen from the upper end was 16.9(±2.22)cms.

Radius: A total of 60 radii were studied, of which 30 were belonging to the left side and 30 were belonging to the right side. Total numbers of nutrient foramen were 62, of which single nutrient foramen found in 58 and double nutrient foramen found in two bone. Most of the nutrient foramen found on anterior surface of radius. All the nutrient foramen directed upwards i.e. towards elbow. Average length of radius was 23.7 (±1.77) cms; average distance of nutrient foramen from the upper end was 8.2 (±1.03) cms.

Ulna: A total of 60 ulnae were studied, of which 30 were belonging to the left side and 30 were belonging to the right side. Total number of nutrient foramen was 60, of which all had a single nutrient foramen.
Most of the nutrient foramen found on anterior surface of ulna. All the nutrient foramen directed upwards i.e. towards elbow. Average length of ulna was 25.4 (±1.79) cms; average distance of nutrient foramen from the upper end was 9.1 (±1.52)cms.

Discussion: The location of the nutrient foramina is predominant on the anterior aspect of the upper limb long bones, and on the posterior aspect of the lower limb long bones. The majority of the bones studied had a single nutrient foramen, which may represent a single source of blood supply.

The diaphysial nutrient foramina in the humerus, are located at between 50 and 65 % of the total length; in the radius and ulna, at between 25 and 50 %; i.e. the middle third of the bone.F. Forriol Campos et al[7]In present study, In the upper limb, foramina were located on the diaphysis 29.6 – 60.6% of the overall length of the humerus, 21.42 – 39.28 % for the radius and 21.28 – 51.42 % for the ulna.

The mean FI for the upper limb bones was 55.2% for the humerus, 35.7% for the radius, and 37.9% for the ulna.(PEREIRA, G. A. M. et al[9])In present study, The mean FI for the upper limb bones was 55.4% for the humerus, 34.7% for the radius, and 36.0% for the ulna.

In the study of 200 human humeri 77% foramina were found medially; on AMS. Of 200 humeri, 63% had a single NF which implies that the major blood supply to humeral shaft will enter at one particular point.(Dr. Hemang Joshi et al[10]) In present study, 89.6 % NF were foundon AMS and 10.4 % on PS of humerus. In 60 humeri, single NF were found in 45 (75.0%), two in13 (21.7%) and three in 3 (3.3%). The mean FI for the humerus was 32.7.

In case of radius, 94.4% had single foramen, 1.4% had double foramen, and in 4.2% of the cases, it was absent. With respect to ulna, all the 75 bones had single foramen. The mean FI was 34.4 for both the ulna and radius.[11] In present study, 35 (56.5 %) NF were found on AS, 4 (6.5 %) on ASAB, 16 (25.8 %) on ASMB, 2 (3.2 %) on MB, 5 (8.0 %) on

PSMB of radius In 60 radius, single NF were found in 58 (96.7 %), two in 2 (3.3 %).All the NF directed upwards i.e. towards elbow. The mean FI for the radius was 32.7.

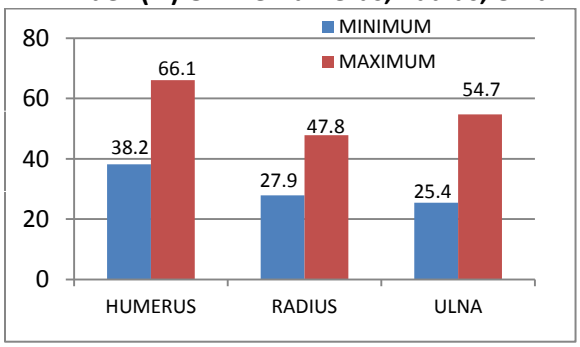
A total of 32 ulnae were studied. Total number of NF was 36, of which single NF found in 28 and double NF found in four bones. Most of the NF found in the middle one third and anterior surface of ulna. All the NF directed upwards i.e. towards elbow. Average length of ulna was 24.73cms; average distance of NF from the upper end was 7.16 cm.[12]

In present study, 60 (100 %) NF was found on AS of ulna. In 60 ulnas, single NF was found in 60 (100%). The entire NF directed upwards i.e. towards elbow. The mean FI for the ulna was 36.0.

Table-1 Foraminal Index (Mean Values)

	Present study (2012)	Pereira, G. A. M. (2011) (9)	B. V. Murlimanju (2011) (11)	V. R. Mysorekar (1967) (13)
HUMERUS	R= 55.6	55.2	57.6	R= 52.6
	L= 55.2			L= 54.0
RADIUS	R= 35.2	35.7	34.4	R= 37.5
	L= 34.2			L= 36.5
ULNA	R= 37.9	37.9	34.4	R= 39.4
	L= 34.1			L= 41.6

Graph 1: Graphic Localization Of The Nutrient Foramina (NF), Independent Of The Surface In Each Bone, Based On The Range Of The Foramen Index (FI) Of The Humerus, Radius, Ulna.



FI

BONE

Conclusion: From the study of 180 adult human long bones of the upper limbs (60 humerus, 60 radius, 60 ulna) following general conclusions can be derived. The position of the NF on the shaft of a long bone is very variable.The proportion between the total length of a long bone and the distance of the NF from upper end is not constant. Similar long bones having the same or nearly the same lengths possess NF at varied distances. So also the similar long bones possessing the same or nearly the same distance of the NF from any one of the ends may not have the same length. The presence of more than one NF in a long bone is found in humerus and radius. Direction of NF remains same in a particular long bone.Size of NF varies in a particular long bone. Fracture at the site of NF heals slowly or not at all, and chances of non-union are too much. Most of the long bone analysed in this study have only one NF and may represent the only source of blood supply. Thus the area of NF distribution must be, whenever possible avoided during surgery. The present investigation provides additional information on the upper limb long bone nutrient artery foramina. As techniques such as microvascular bone transfer are becoming more popular, information relating to the anatomical description of these foramina is vital to preserve thecirculation of affected bony structures. It is also of relevance for those clinicians involved in surgical procedures where patency of the arterial supply to long bones is important.

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