A STUDY OF NUTRIENT FORAMINA IN HUMAN UPPER LIMB LONG BONES

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ABSTRACT

BACKGROUND

Nutrient foramina are cavities that conduct nutrient arteries and peripheral nerves on the shaft of long bones. Long bones receive most of the interosseous blood supply from nutrient arteries and sometimes through the periosteal vessels.

The aim of this study was to determine the common location, direction & number of nutrient foramina of upper limb long bones.

MATERIALS & METHODS

This is descriptive study of a total 150 human upper limb long bones {50 humeri, 50 radii & 50 ulnae} taken from Department of Anatomy, Guntur Medical College, Guntur and each was studied for location, direction & number of nutrient foramina.

RESULTS

In humerus, a single nutrient foramen was found in 78% and double in 22% of bones, of them 62% foramina were on antero-medial surface, 25% on medial border, 5% on anterior border, 5% on posterior surface & 3% on lateral border. 87% of nutrient foramina were in middle third of shaft of humerus. All radii had single nutrient foramen, of them 70% were on anterior surface & 30% on interosseous border. 74% of nutrient foramina were in middle third & 26% were in upper third of shaft of radius. 98% of ulnae had single nutrient foramen & 2% had double nutrient foramina, of them 78.4% were on anterior surface, 11.8% on posterior surface, 5.9% on interosseous border & 3.9% on anterior border. 88.2% of nutrient foramina were in middle third & 11.8% in upper third of bone. All nutrient foramina were directed away from the growing end i.e., towards the elbow.

CONCLUSION

The study of nutrient foramina is of clinical importance in surgical procedures like orthopedic transplant techniques & microvascular bone transfer procedures.

KEY WORDS

Nutrient Foramen, Upper Limb Long Bones, Foraminal Index.

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BACKGROUND

Nutrient foramen is defined as the largest of the foramina present on the shaft of long bone allowing nutrient artery to enter the bone.¹ The nutrient artery is the principal source of blood supply to a long bone & particularly important during its active growth period in the embryo, fetus, as well as during the early phase of ossification.² Long bones are supplied by four sets of arterial system- nutrient artery, epiphyseal, metaphyseal and periosteal arteries. The nutrient artery obliquely penetrates the shaft at their entrance point & angulation being relatively constant. Once it reaches the medullary cavity, divide into ascending, descending branches & supply bone marrow, inner two-thirds of compact bone.³ Reduction of blood flow to bone leads to ischemia of the metaphysis & growth plate.⁴

The direction of the nutrient foramen is away from the growing end of the bone, they seek the elbow and flee from the knee⁵, showing varying directions in both limbs, this is because one end of the limb bone grows faster than the other.

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A considerable interest in studying nutrient foramen resulted not only from morphological, but also from clinical aspects. Nutrient foramen reflects to a certain degree the bone vascularization.⁶ Some pathological bone conditions such as developmental abnormalities, fracture healing, acute hematogenic osteomyelitis are closely related to the vascular system of the bone. The data is also helpful in procedures like bone grafting, tumour resection & transplantations techniques.^{7,8}

There is still a need for a greater understanding of the direction, location & number of in nutrient foramina in human upper limb long bones. So, the aim of the present study is to record the direction, location & number of nutrient foramina in long bones of upper limb.

MATERIALS & METHODS

The descriptive study was conducted in Department of Anatomy, Guntur medical college, Guntur. The material consists of 50 humeri, 50 radii & 50 ulnae. All bones are normal with no pathological changes. Age & sex characteristics of the bones studied were unknown.

The nutrient foramina were observed with help of a hand lens, they were identified by their elevated margins & by the presence of a distinct groove proximal to them.

For each bone-

1. Total length of the bone was measured using Hepburn osteometric board.
2. The number of nutrient foramina were observed on the shaft.
3. Surface of bone on which nutrient foramen was located.

4. Location of nutrient foramen in relation with the length of the bone by calculating.

Foraminal Index

- $FI = DU / TL \times 100$ {Hughes, Shulman}.
- FI = Foramina index.
- DU = Distance from upper end to nutrient foramen.
- TL = Total length of bone.

Depending on FI, Position of Nutrient Foramen was divided into 3 Types

1. Upper third - FI up to 33.33
 2. Middle third - FI from 33.34 to 66.66
 3. Lower third - FI above 66.67
5. A fine stiff wire was used to observe the direction & obliquity of the nutrient canal of nutrient foramen.

RESULTS

Name of the Bone	No. of Bones with Single NF	No. of Bones with Double NF
Humerus	39 {78%}	11 {22%}
Radius	50 {100%}	---
Ulna	49 {98%}	1 {2%}

Table 1. Incidence of Number of Nutrient Foramina in Upper Limb Long Bones

Location of Nutrient Foramen in 50 Humeri	Number of Nutrient Foramen	Percentage
Anteromedial Surface	38	62%
Medial Border	15	25%
Lateral Border	2	3%
Posterior Border	3	5%
Posterior Surface	3	5%

Table 2. Percent Distribution of Location of Nutrient Foramen In 50 Humeri

Location of Nutrient Foramen in 50 Radii	Number of Nutrient Foramen	Percentage
Anterior Surface	35	70%
Interosseous Border	15	30%

Table 3. Percent Distribution of Location of Nutrient Foramina In 50 Radii

Location of Nutrient Foramen in 50 Ulnae	Number of Nutrient Foramen	Percentage
Anterior Surface	40	78.4%
Posterior Surface	6	11.8%
Interosseous Border	3	5.9%
Anterior Border	2	3.9%

Table 4. Percent Distribution of Location of Nutrient Foramina In 50 Ulnae

Name of the Bone	Upper Third	Middle Third	Lower Third
Humerus	3 {5%}	53 {87%}	5 {8%}
Radius	13 {26%}	37 {74%}	---
Ulna	6 {11.8%}	45 {88.2%}	---

Table 5. Percentage Distribution of Different Locations of Nutrient Foramina According to Foraminal Index in Upper Limb Long Bones

All nutrient foramen directed towards elbow i.e., away from growing end.

There was no change in the obliquity of canal whether they are in the center or at the peripheral of the bone.

Figure 1. Humerus Showing Double Nutrient Foramina {NF}, Both on Anteromedial Surface of The Shaft, Both Directing Downwards (Towards Elbow)

Figure 2. Humerus Showing Double Nutrient Foramina {NF}, Proximal Foramen on Posterior Surface, Distal Foramen on Medial Border of The Shaft, Both the Foramina Are Directing Downwards (Towards Elbow)

Figure 3. Radius Showing Single Nutrient Foramen {NF} On Anterior Surface of The Shaft, Directing Upwards

Figure 4. Radius Showing Single Nutrient Foramen {NF} On Interosseous Border of The Shaft, Directing Upwards

Figure 5. Ulna Showing Single Nutrient Foramen {NF} On Anterior Surface of The Shaft, Directing Upwards

Figure 6. Ulna Showing Single Nutrient Foramen {NF} On Anterior Border of The Shaft, Directing Upwards

DISCUSSION

Number of Nutrient Foramina

In the present study, in humerus single nutrient foramen had a higher percentage {78%} compared to that of double {22%}. Many authors like Chandrasekaran S, Shanthi KC⁹ {76.7%}, Bhojaraja VS et al¹⁰ {77%}, Longia GS et al¹¹ {85%} reported similar results. Absence of nutrient foramen was reported by

some authors like Ukoha UU et al¹² {26%}, Longia GS et al¹¹ {2%}, Bhojaraja VS et al¹⁰ {3%}. Kizilkanat E et al⁷ observed 4 nutrient foramina in 1 % of humeri.

In the present study, all radii examined had a single nutrient foramen similar to that of Forriol Campos F et al.⁴ Some authors like Veeramuthu. M et al,¹³ Longia GS et al,¹¹ Kizilkanat E et al,⁷ Dr. Meenakshi Parthasarathy et al¹⁴ reported single nutrient foramen in more than 90 % radii and remaining had double nutrient foramen. Radii without nutrient foramen were also observed by Dr. Meenakshi Parthasarathy et al¹⁴ {4.2%}, Ukoha UU et al¹² {16%}.

In the present study in ulnae, 98 % had single nutrient foramen similar to most authors. Dr. Meenakshi Parthasarathy et al,¹⁴ Ukoha UU et al¹² found ulna without nutrient foramen. Longia GS et al¹¹ reported ulna with 3 nutrient foramina.

Position of Nutrient Foramina

In the present study, humeri had most of the nutrient foramina on anteromedial surface {62%} followed by medial border {20%}. Similar findings are reported by Kizilkanat E et al⁷ {62%}, Murlimanju BV et al¹⁵ {60%}, Dr. Meenakshi Parthasarathy et al¹⁴ {60%}. Asharani SK, Ningaiah A¹⁶ observed more nutrient foramina on medial border {57%} than anteromedial surface {32%}.

In radius 70% of nutrient foramina were on anterior surface & 30% on interosseous border.

In ulna 78.4% of nutrient foramina were on anterior surface.

Many authors stated that most of nutrient foramina were on anterior surface in both radius & ulna.

In the present study most of the nutrient foramina were in middle third of bone {humerus-87%, radius-74%, ulna-88.2%} which correlates with study of many authors. Longia GS et al,¹¹ Mysorekar VR,¹⁷ Veeramuthu. M et al¹³ observed most of the nutrient foramina in middle third of radius ulna.

According to Murlimanju BV et al,¹⁵ Dr. Meenakshi Parthasarathy et al¹⁴ in humerus more than 70% of nutrient foramina were seen in 3/5th part of bone, in radius & ulna more than 85% of nutrient foramina were seen in 2/5th part of bone.

Direction of Nutrient Foramina

This study follows the dictum "To the elbow I go, from the knee I flee".

In humerus the nutrient foramina were directed distally & in radius, ulna they were directed proximally. Similar observations are reported by Shulman SS¹⁸ & Longia GS et al.¹¹ Ukoha UU et al¹² reported a radius with nutrient foramen directed distally.

CONCLUSION

In upper limb long bones, a single nutrient foramen on flexor surface in middle third of the shaft is common. All the foramina were directed towards elbow. The present study confirmed previous reports. Exact number, position & direction of nutrient foramina are important to avoid damage to the nutrient vessels during surgical procedures like bone grafting, microsurgical vascularized bone transplantation and fracture management. Delayed or non-union following trauma may be directly related to the absence of nutrient arteries entering the bone.

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