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A TOPOGRAPHICAL STUDY OF NUTRIENT FORAMEN IN DRY HUMAN LONG BONES OF THE SUPERIOR EXTREMITY

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ABSTRACT

Nutrient artery is the principal source of nutrition to the long bones and a sound knowledge of its topography will help surgeons and oncologists in certain operative procedures to preserve the circulation. The aim of our study was to determine the direction and position of nutrient foramina with help of foramen index. The study was conducted in total 114 long bones of arm and forearm and the material collected for our study was from the department of Anatomy, ELMC&H, Lucknow and Department of Anatomy, King George's Medical University, Lucknow. Deformed and Damaged bones or bones with callus formation were excluded from the study. Direction of nutrient foramen was observed in all humerus (38 bones) downward. In case of radius (38 bones) and ulna (38 bones) the direction was found towards the upper end. In our study 92.10% humerus bones show the location of nutrient foramen in anteromedial surface. The anatomical data collected from this study elucidates the importance of nutrient arteries in microvascular bone transfer since it has become a very popular procedure.

KEYWORDS: Nutrient artery, Nutrient foramen, Long bones, Vascularization.

INTRODUCTION

Nutrient artery enters the medullary of the bone through the nutrient foramen (1). Embryologically one end of the limb grows faster than the other hence the nutrient foramen are directed towards the elbow but away from the knee (2). Nutrient foramen is a surface opening of nutrient canal passing obliquely through the compact bone of the shaft of long bone to enter the marrow cavity. It is directed away from the growing end in a typical long bone. The diaphyseal nutrient artery enters through nutrient foramen into canal. It divides into an ascending and descending branch on reaching the medullary cavity. It will supply the shaft. The nutrient artery supplying the radius arises from the anterior or posterior interosseous artery. Any damage to the precise area of nutrient foramen, nutrient canal or nutrient artery by traumatic or iatrogenic reasons may result with delayed union, non- union of the bone following fractures or bone graft, because healing of fracture, or bone graft is dependent on blood supply (3).

A sound knowledge of the topography, frequency and morphometryof nutrient foramen is essential for success of bone transplantation procedures (4) along with adequate vascularization (5). 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 (6). When compromised especially in childhood, medullary bone ischemia occurs with less vascularization of the metaphysis and growth plate (7). Study of relative relationship between the length of bone and distance of nutrient foramen from either ends is useful in calculating the length of a long bone from a given fragment, which is important in medico-legal and anthropological work. From the length of the long bones height of an individual can be reconstructed (8).

MATERIAL AND METHOD

1. Study subjects: The study was conducted in total 114 long bones of arm and forearm irrespective to sex and age; the material was collected for our study from department of Anatomy, ELMC, Lucknow and Department of Anatomy, King George's Medical University, Lucknow.
2. Osteometric board.
3. Hand lens
4. Hypodermic needle (26 gauge)
5. Nutrient foramen was observed in all bones by the naked eye and then with the help of hand lens, to determine the number and location (with respect surface).
6. Distance of nutrient foramen from the proximal end of the bone and total length of bone was measured by using osteometric board.

7. The direction of nutrient foramen was observed by their elevated margin and by the presence of distinct groove of nutrient foramen and it was confirmed with the help of hypodermic needle. The total length of long bones and distance of nutrient foramen from the upper end also measured.
8. Position was determined by calculating the foramen index using HUGH"S formula (9).

RESULTS

The incidence of location of nutrient foramen with respect to different surfaces and borders was observed, and it was found that in case of humerus in (37 bones) 92.1% bones the nutrient foramen was located in the anteromedial surface and only in (1bone) 7.9% bone nutrient foramen was found in medial border . In case of radius (38 bones) all bones show the location of nutrient foramen in anterior surface. In ulna (38 bones) all nutrient foramen was located in anterior surface (fig 1).

Direction of NF

The nutrient foramen was directed downwards in all humerus (38 bones). In case of radius (38 bones) and ulna (38 bones) the direction was found towards the upper end.

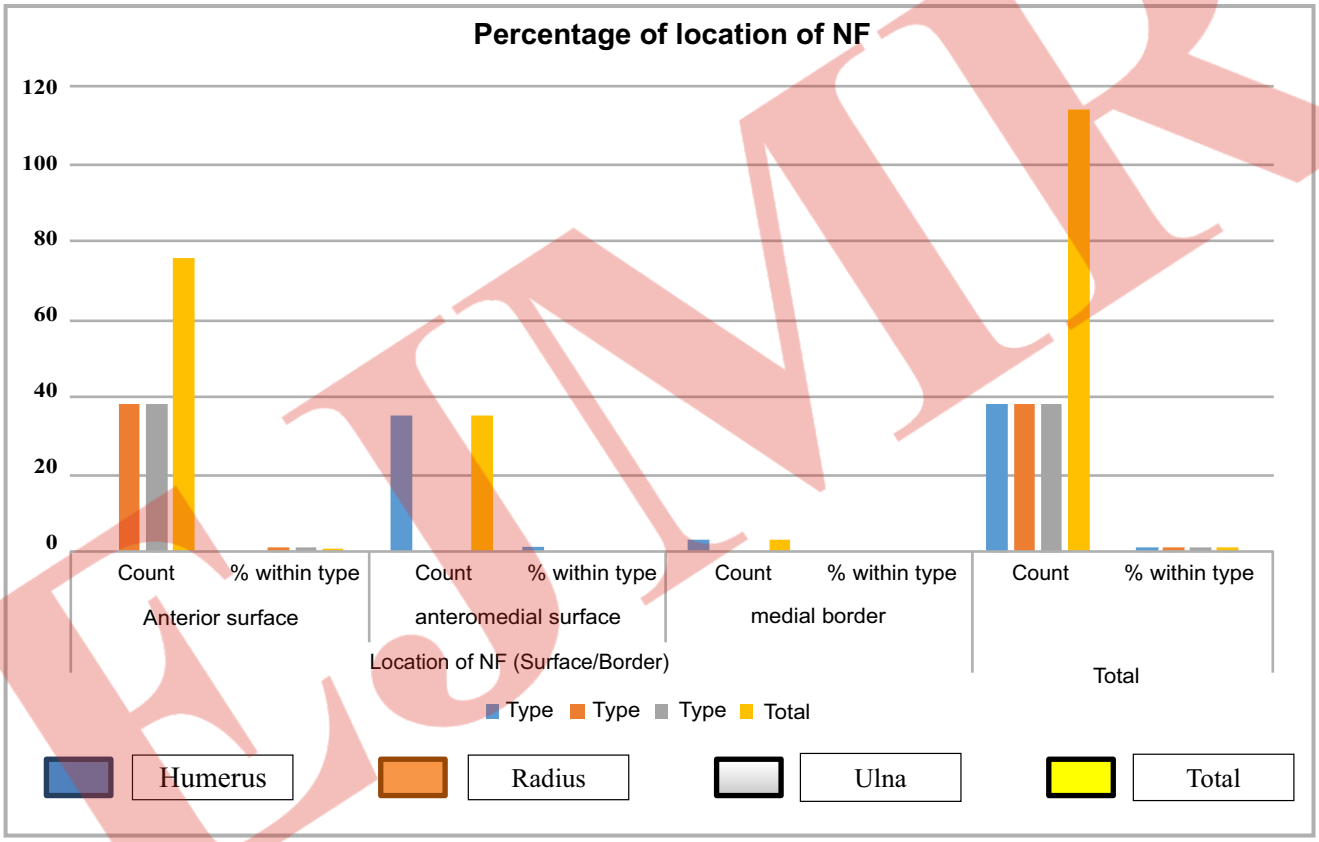

Fig 1: Showing the Percentage of Location of Nutrient Foramen

			Type			Total
			Humerus	Radius	Ulna	
Direction of NF	Downward	Count	38	0	0	38
		% within type	100.0%	.0%	.0%	33.3%
	Towards the upper end	Count	0	38	38	76
		% within type	.0%	100.0%	100.0%	66.7%
Total		Count	38	38	38	114
		% within type	100.0%	100.0%	100.0%	100.0%

Table 1: Showing the Direction of Nutrient Foramen

Distance of nutrient foramen from the upper end

The mean distance of the nutrient foramen from the upper end in 38 humeri was found to be 18.47, the mean distance of the foramen in case of 38 radius bones was found to be 8.10, the mean distance of the foramen in 38 ulna bones was found to be 9.10.

CASE SUMMARIES			
Type		Total length (cm)	Distance of NF from upper end (cm)
HUMERUS	N	38	38
	Mean	31.18	18.47
	Std. Deviation	1.078	1.512
RADIUS	N	38	38
	Mean	22.67	8.10
	Std. Deviation	1.466	1.018
ULNA	N	38	38
	Mean	25.64	9.10
	Std. Deviation	1.136	.960
Total	N	114	114
	Mean	26.50	11.89
	Std. Deviation	3.750	4.838

Table 2: Showing the Mean Distance of Nutrient Foramen From the Upper End

DISCUSSION

Location of nutrient foramen

Arvind KumarPankajet al. in the year 2017 observed that the maximum number of foramina were present on the antero-medial surface followed by the posterior surface. Majority of foramen were present in the middle third region of the diaphysis of humerus (10). Asharani S K et al. in August 2016 found that in the majority of the bones, nutrient foramen is located either on the medial border (57%) or on the antero-medial surface (43%) (11). Guthi Reddy Manoj Kumar Reddy et al. in April 2016 found that 90.7% of radius had nutrient foramen on anterior surface, 7.4% of radius had nutrient foramen on interosseous border and only 1.9% of radius had nutrient foramina on posterior surface and in case of ulna 94% bones had nutrient foramina on anterior surface, 4% bones had nutrient foramen on interosseous border (12). BichitranandaRoul et al. in March 2015 observed that in Humerus, nutrient foramina was found to be in the middle 1/3rd in 36 bones, in one bone it was found to be in the lower 1/3rd & no nutrient foramen in upper 1/3rd. In the radius nutrient foramina was found in the upper 1/3rd in 9 cases and in 28 cases it was found in middle 1/3rd, no nutrient foramen was found in lower 1/3rd. In ulna nutrient foramina was found at the upper 1/3rd in 12 cases in middle 1/3rd in 25 cases and not found in lower 1/3rd (13). K S Solanke et al. in February 2014 found that majority (79.92%) of bones had nutrient foramen in the middle third of the shaft, whereas the distal third was rare position (14). In our study 92.10% of nutrient arteries in humerus were present on the anteromedial surface while 7.9% were present on the medial border.

Direction of nutrient foramen

Arvind kumar Pankajet al. in, 2017, in their study found that the direction of nutrient foramina in all the humerii was downward (10). Asharani S K et al. in August 2016, in their study observed that the direction of foramen is towards the elbow joint (11). Satish M. Patelet al.in August 2015 in their study found that all the nutrient foramen except one (in the radius) were directed towards the elbow (15). Bichitrananda Roul et al. in March 2015 in their study emphasized that the direction of nutrient foramen in human long bones is directed away from growing end (13).Vijayalakshmi S. Bhojaraja et al. in Jul-Dec 2014 in their study observed that all the nutrient foramen were directed towards the distal end (16). Dr. OjaswiniMalukar, Dr. Hemang Joshi in April-June 2011 observed that the for miniature long bones the direction was away from the growing end without any exception (17). KS Solanke et al in 2014 and Ukoha Ukoha et al in 2013 also reported the direction of nutrient artery similar to our study where the direction of nutrient foramina was downwards in the humerus, while it was towards the upper end in radius and ulna (14, 18).

CONCLUSION

Total one hundred fourteen long bones of upper limb i.e. thirty eight each of the Humerus, Radius and ulna was taken from Department of Anatomy, Era's Lucknow Medical College, and Department of Anatomy, King George Medical University, Lucknow, and were studied for the location, direction of Nutrient foramen. It was found that most of the long bones follow the dictum "Towards the elbow I go, away from the knee I flee". In the present study most of humerishow the location of nutrient foramen on theanteromedial surface, but in some cases bones show the location of nutrient foramen on the medial

border also.In case of radius and ulna all bones show the location of nutrient foramen on the anterior surface.The knowledge about the location of the nutrient foramina is highly important because of the increased chances of damage to the nutrient artery during open or closedsurgical procedures.In bone grafts, the nutrient blood supply is crucial and it should be preserved in order to promote the fracture healing hence a sound knowledge of the topography and morphometryof nutrient foramina is of importance to orthopaedic surgeons and oncologists.

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