RESEARCH PAPER

Anatomical Variations in Diaphyseal Nutrient Foramina of Humerus and Its Clinical Significance

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ABSTRACT

Background:
Humerus is the long bone of the upper arm region in the human body. The nutrient foramen is an opening on the surface of the shaft of the bone, passing through the cortex and ultimately opening into the medullary cavity. The nutrient artery to the bone passes through this foramen. Anatomical knowledge regarding the number, location, position, size, and direction of nutrient foramina is useful to preserve them during surgical repair of fractures of the humerus and to avoid damage to the nutrient artery, thereby preventing complications such as delayed union or non-union of fractures.

Methods:
The study was conducted on 100 dry humeri in the Department of Anatomy, Kakatiya Medical College, Warangal, Telangana State, India. Anatomical location, number, size, position, and distance of nutrient foramina from the proximal and distal ends of the humerus were determined.

Results:
In the present study of 100 dry humeri, the total number of nutrient foramina was 126. **Number of NF:** Single nutrient foramen was seen in 75 bones (75%), double nutrient foramen was seen in 24 bones (24%), and triple nutrient foramina were seen in 1 bone (1%). **Position of NF:** Middle one-third had 117 NF (92.85%), proximal one-third had 5 NF (3.96%), and distal one-third had 4 NF (3.17%). **Location of NF:** Anteromedial surface had 68 NF (53.968%), medial border 40 NF (31.746%), lateral border 6 NF (4.76%), anterolateral surface 3 NF (2.38%), and posterior surface 9 NF (7.14%). **Size of NF:** Primary dominant (48 NF) 38.09%; secondary (78 NF) 61.90%. **Direction and obliquity of NF:** All nutrient foramina were directed downwards and oblique.

Conclusion:
An understanding of the morphometric study of the nutrient foramen in long bones is important in orthopaedic surgical procedures such as joint replacement therapy, fracture repair, bone grafts, and vascularised bone microsurgery to preserve the nutrient artery and to avoid complications like malunion and non-union.

Keywords: Humerus; Nutrient Foramina (NF); Nutrient Artery; Distance Nutrient Foramina (DNF); Foraminal Index (FI)

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INTRODUCTION

Humerus long bone of arm region.Nutrient foramen is a cavity allowing passage of a nutrient artery and a peripheral nerve into the diaphysis of a long bone. Nutrient foramen are seen in surface and borders of shaft of a long bone,passing through cortex ultimately opens into medullary cavity.one or two main diaphyseal nutrient arteries enter the shaft obliquely through nutrient foramen,which lead to nutrient canal their sites of entry and angulations are

almost constant directed away from the dominant growing epiphysis.Nutrient arteries do not branch in their canals but divide into ascending and descending branches in the medullary cavity.These approach the Epiphysis, dividing repeatedly into small helical branches close to the endosteal surface. The endosteal vessel is vulnerable during surgical operations such as intra medullary nailing,which involve passing metal implants into the medullary canal.Near the Epiphysis,diaphyseal vessel is joined by terminal branches of numerous metaphyseal and epiphyseal arteries.Periosteal arteries are the arteries of periosteum.Berard (1835)was first to point out that in human long bones,nutrient canals were obliquely disposed away from growing end.The dissection room jingle"To the Elbow I go,away from the knee I flee"is originally in French.Aucoude je mappuis,dugenoujem'enfuis".This is called Berard rule of canal direction.It has been suggested that direction of nutrient foramen is determined by growing end of the bone.The growing end is supposed to grow at least twice faster than other end.The diaphyseal nutrient vessels move away from the growth extremity dominant in the bone.

AIMS ANDOBJECTIVES

- To provide supportive evidence for existing data and to add new findings for benefit of clinical research. To determine morphological variations in Nutrient foramina in diaphysis of Humerus.The study criteria include number,size,Location,Position,Direction and Obliquity of nutrient canal.

METHOD AND MATERIALS:-

NOTE-Institutional Ethical committee Permission taken for conduct of study :-An observational study was conducted on 100 Dry Humerii that includes both right & Left sides at Kakatiya Medical College,Warangal for a period of 24 months.**Materials:**Osteo metric Board:Used for measuring total Length of bone. Vernier Calipers: To measure distance of Nutrient Foramen from proximal End and Distal end. 20,24 Guaze hypodermic needles:Used for measuring caliber of nutrient foramen and to confirm patency of Foramen. Magnifying Hand Lens:To identify the nutrient foramen.

RESULTS

In Humerus present study of 100 dry humerii,Total number of Nutrient foramina found 126

- **Number of nutrient foramina** Single nutrient foramen were seen in75 bones -75NF, Double nutrient foramen were present in 24bones-48NF, Triple nutrient foramina seen in 01 bone-3NF
- **Position of Nutrient Foramina** Proximal 1/3rd are 5Nutrient Foramina, Middle 1/3rd are 117Nutrient Foramina, Distal 1/3rd are 4Nutrient Foramina
- **Location of Nutrient Foramina** 68 Nutrient Foraminaon Antero medial surface of humerus 3 Nutrient Foramina on Antero lateral surface 40 Nutrient Foramina on Medial border 6 Nutrient Foramina on lateral border 9 Nutrient Foramina on posterior surface
- **Size of Nutrient Foramina in Humerus 100bones(126NF)**
  Primary dominant (48NF) are Large in size 24Gauze hypodermic needle can pass through it
  Secondary(78NF) are small size 24Guaze hypodermic needle cannot pass through it
- **Direction and obliquity of Nutrient Foramina**
  In Humerus out of 100 bones(126 NF)all nutrient foramen are directed downwards towards elbow.
- **TOTAL BONE LENGTH OF HUMERUS(Range,Average):-**
  Range of Total Length for Right Humerus (Min 26cm- Max 36cm), Range of Total Length for Left Humerus(Min 25.5cm-Max37.5cm) Average Total Length for Right Humerus was(31.066cm) Average Total Length for Left Humerus was (31.288cm)
- **DNF FROM PROXIMAL AND DISTAL ENDS OF HUMERUS:-**
  Distance of Nutrient Foramina from Proximal end of Right humerus-16.329cm,Left humerus-16.907cm.
  Distance of Nutrient Foramina from Distal end of Right humerus-12.990cm,Left humerus-13.809cm
- **CALCULATION OF THE FORAMINAL INDEX (FI)** FI=(DNF/TLX100)
  DNF=Distance of nutrient Foramen from proximal end of the bone
  TL=Total bone
  FI=Foraminal Index
- **FORAMINAL INDEX OF HUMERUS**
  Range of Foraminal Index of Right Humerus(Max65.45-Min19.71)
  Range of Foraminal Index of Left Humerus(Max74.83-Min21.
  Mean of Foraminal Index of Right Humerus 55.66 Mean of Foraminal Index of Left Humerus 56.06
- **DIVISIONS OF POSITION OF NUTRIENT FORAMEN ACCORDING TO FI:**
  The position of the foramen was divided into three types according to FI
  Type 1:FI upto 33.33 foramen was in proximal third of th bon Type 2:FI from 33.33 upto 66.66,foramen was in Middle third of bone. Type 3:FI above 66.66,the foramen was in distal third of the bone.



TL=Total bone length measured using osteometric board



DNF from distal end of the bone by using vernier calipers



50 Dry Right Humerii used for study at Kakatiya Medical college,warangal.



50 Dry Left Humerus Bones taken for study at Kakatiya Medical college,





Humerus Triple Nutrient foramen Nutrient foramen on Posterior surface

DISCUSSION

In present study -The Number of NFout of 100 humeri 75 bones(75%) had single nutrient foramen,24 bones(24%) had double nutrient foramina,1 bone (1%)had triple foramen.**The Location of NF** out of 100 Humeri ,Total 126 nutrient foramen ,68 Nutrient foramina(53.96%) were found on Antero medial surface,03(2.38%) on Antero Lateral Surface,40(31.74%) on Medial border,9 (7.14%)Posterior surface,06 (4.76%)on Lateral Border. **The Position of NF**out of 126 NF ,117 (92.85%)were present in middle third of shaft of Humerus ,Proximal third shows 5 bones(3.96%), Distal third shows 4 bones(3.18%).

Comparative study of research on Number of Nutrient foramina in Humerus

Authors Name	Number of Bones Studied	Single NF	Double NF	Triple NF	Quadruple NF
caroll	71	48	20	03	0
Mysorekar	180	104	68	05	02
Kizilkanant	101	69	22	07	01
Present	100	75	24	01	0

Comparative study of Research on Position of Nutrient Foramina in Humerus

Authors Name	Number of Bones studied	Number of Nutrient Foramina	NF in Proximal 1/3rd of bone	NF in Middle 1/3rd of bone	NF in Distal 1/3rd of bone
Mysorekar	180		3%	96%	1%
Longia	200	222	08	202	12
Present study	100	126	5	117	4

Comparative study of Location of Nutrient Foramina in Humerus

Authors Name	Total Number of Bones studied	NF	NF in Antero Medial Surface	NF in Antero Lateral Surface	NF in Posterior Surface	NF in Medial border	NF in Lateral Borderr
Mysorekar	180	263	107	50	03	100	03
Asharani	120	130	52	03	04	68	03
Present study	100	126	68	03	09	40	06

CONCLUSION

The morphometric study of nutrient foramen with regard to the number,Location and position is of great importance for good supportive basis for osteological studies by anatomists ,clinicians,radiologists,orthopaedic surgeons,vascular surgeons all over the world. Radiologists can take preoperative angiogram or Angio CT scan to confirm the presence or absence of nutrient artery ,supplying the diaphysis of the long bone . orthopaedic surgeons by understanding of the morphometric study of Exact position location,distribution,location of nutrient foramen plan for surgical procedures joint replacement therapy,fracture repair ,vascularised free bone grafts bone to preserve endosteal as well as periosteal blood supply.

This anatomical knowledge of nutrient foramen is helpful in preserving nutrient artery to avoid injury and prevent complications like non union and mal union during open reduction and internal fixation procedures.

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