Original Research Article

Study on the anatomical variations in diaphyseal nutrient foramina of humerus

Shishir Kumar[1], Shivarama Ch[2*]

[1,2]Assistant Professor, Department of Anatomy, Kanachur Institute of Medical Sciences, Mangalore, INDIA.
Email: drshivac@gmail.com

Abstract

Background: The knowledge of variations of nutrient foramina will be helpful for orthopaedic surgeons to avoid causing damage to the nutrient artery during an open reduction to improve fracture healing. Present study was aimed to study anatomical variations in diaphyseal nutrient foramina of humerus. **Material and Methods:** Present study design was descriptive and observational, conducted in 100 normal adult humans, cleaned and dried Humeri, with no appearance of pathological changes and fracture. **Results:** Among 100 normal adult humans, cleaned and dried Humeri, 50 were of right side and 50 of left side. Majority of right humeri had one nutrient foramen (82 %) followed by 2 and none nutrient foramen in 14 % and 4 % cases respectively. Majority of left humeri had one nutrient foramen (88 %) followed by 2, 3 and none nutrient foramen in 8 %. 4 % and 4 % cases respectively. Majority of nutrient foramen were located on Antero-medial Surface (83.64 % in right and 78.18 % in left). Majority of nutrient foramen were in zone 2 of humerus (89.09 % in right and 83.64 % in left). **Conclusion:** The knowledge of the nutrient foramina morphometry is consequently important in various orthopedic surgical procedures, such as joint replacement therapy, fracture repair, bone grafts, vascularized bone microsurgery and also in medico-legal cases.

Keywords: nutrient foramina, morphometric study, microsurgery, diaphyseal

[*]**Address for Correspondence:**
Dr Shivarama Ch, Assistant Professor, Department of Anatomy, Kanachur Institute of Medical Sciences, Mangalore, INDIA
Email: drshivac@gmail.com

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INTRODUCTION

The nutrient artery is a principal source of blood supply to long bones and is particularly important during their active growth period in the embryo and fetus, as well as during early phase of ossification. Nutrient foramina through which the nutrient 2 artery enters the bone, is directed obliquely, and edges of the oblique part are elevated for entrance of the nutrient artery.[1,2] The main nutrient foramina of humerus are found in the middle 1/3rd of the anteromedial surface, although various variations have been reported in the number and position of the foramina.[3] In spite of giving optimal treatment, some fractures either heal slowly or fail to heal and may be related to the severity of the injury, poor blood supply, age and nutritional status of the patient or other factors.[4,5] The knowledge of variations of nutrient foramina will be helpful for orthopaedic surgeons to avoid causing damage to the nutrient artery during an open reduction to improve fracture healing. Present study was aimed to study anatomical variations in diaphyseal nutrient foramina of humerus.

MATERIAL AND METHODS

Present study was conducted in the Department of Anatomy, at Kanachur Institute of Medical Sciences, Mangalore, India. Study design was descriptive and observational, study duration was of 2 years (July 2014 to June 2016). We studied 100 normal adult humans, cleaned and dried Humeri, with no appearance of pathological changes and fracture. Nutrient foramina were identified by their elevated margins and by the presence of distal groove proximal to them. Only well-defined foramina on the diaphysis were accepted. All measurements were taken using Vernier calliper. The total length of individual humerus was taken as the distance between superior point on the head and most distal point of medial projection of

trochlea of humerus. Length was measured in mm through osteometric board. Variables studied were number of foramina, direction and obliquity of nutrient foramen, surface on which nutrient foramina were located (antero-medial, posterior and antero-lateral).

Location of foramina was divided into three types as:

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

Type 2: FI below 33.33 up to 66.66, the foramen was in the middle third.

Type-3: FI above 66.66, the foramen was in the distal.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

RESULTS

Among 100 normal adult human, cleaned and dried Humeri, 50 were of right side and 50 of left side. Majority of right humeri had one nutrient foramen (82 %) followed by 2 and none nutrient foramen in 14 % and 4 % cases respectively. Majority of left humeri had one nutrient foramen (88 %) followed by 2, 3 and none nutrient foramen in 8 %. 4 % and 4 % cases respectively.

Table 1: number of nutrient foramina

Side and no.(n) of bones	Incidence of no. of nutrient foramina (%)			
	Absent (0)	One (1)	Two (2)	Three (3)
Right (n=50)	2 (4 %)	41 (82 %)	7 (14 %)	0 (0%)
Left (n=50)	1 (2 %)	44 (88 %)	4 (8 %)	1 (2 %)
Total (n=100)	3 (3 %)	85 (85%)	11 (11 %)	1 (1 %)

Majority of nutrient foramen were located on Antero-medial Surface (83.64 % in right and 78.18 % in left).

Table 2: Situation of nutrient foramina in relation to different surfaces of humerus

Position of foramina	Right (N=55)		Left (N=55)		Total (N=110)	
Antero-medial Surface	46	83.64%	43	78.18%	89	80.91%
Posterior Surface	7	12.73%	9	16.36%	16	14.55%
Antero-lateral Surface	2	3.64%	3	5.45%	5	4.55%
Total	**55**	**100.00%**	**55**	**100.00%**	**110**	**100.00%**

Majority of nutrient foramen were located in zone 2 of humerus (89.09 % in right and 83.64 % in left).

Table 3: Showing distribution of nutrient foramen in respect to zone of humerus.

Zone of humerus	Right (N=55)		Left (N=55)		Total (N=110)	
ZONE-I	4	7.27%	6	10.91%	10	9.09%
ZONE-II	49	89.09%	46	83.64%	95	86.36%
ZONE-III	2	3.64%	3	5.45%	5	4.55%
TOTAL	**55**	**100.00%**	**55**	**100.00%**	**110**	**100.00%**

DISCUSSION

The nutrient blood supply is crucial for any long bones and it should be preserved in order to promote the fracture healing. Absence of NF and hence the nutrient artery can deplete the blood supply to the ossifying bones and can result in ischemia of metaphysic and growth plate.[6] The knowledge of diversity of nutrient foramina has profound importance in orthopaedic surgeries for undertaking an open reduction of a fracture to avoid injury to the nutrient artery and thus lessening the chances of delay or nonunion of the fractures.[7] Moreover, the presence of preserved nutrient blood supply is essential for the survival of the osteocytes in cases of tumor resection, trauma, and congenital pseudoarthrosis.[8,9] Khan AS *et al.*,[10] noted that out of 75 humerus bones, 68 (90.67%) were having single nutrient foramen and in 74 (98.67%) humerus bones, nutrient foramina were directed distally. Mean distance of the nutrient foramina from the medial epicondyle of the humerus was 9.92±1.93cm in all bones; 10.44±1.92cm on the left sided (n=41) bones and 9.36±1.95cm on the right sided (n=34) bones. Overall, 96% (n=72/75) of nutrient foramina were located on the middle 1/3rd of anteromedial surface, 2.67% (n=2/75) on the posterior surface and 1.33% (n=1/75) on the antero-lateral surface. While 97.5% (n=33/34) of nutrient foramina on right humeri and 95.13% (n=39/41) of nutrient foramina on left humeri were located on antero-medial side. In study by Asharani SK *et al.*,[11] 87% bones have one and 11% have two nutrient foramina respectively. In Majority of the bones studied, the nutrient foramen is located either on the medial border (57%) or on the anteromedial surface (43%). In the rest nutrient foramen is located on lateral border (3%), posterior surface (3%) or anterior border(2%). 87% have the nutrient foramen located in Zone II, 22% at the junction between

Zone II and Zone III and 2% in Zone III. The direction of foramen is towards the elbow joint i.e., away from the growing end. Mansur DI *et al.*,[12] observed that 60.87% of the humeri had a single nutrient foramen, 28.85% double foramen, 6.32% triple foramen and 1.98% of humeri had four nutrient foramina where as 1.98% humeri did not have any nutrient foramina. It was concluded that the majority (88.86%) of the nutrient foramina were present on the antero-medial surface, 6.52% on the anterolateral surface and 4.62% on the posterior surface of the shaft of humeri. It was also concluded that most (94.84%) of the foramina present in the zone II followed by zone III (4.62%) then by zone I (0.54%). All foramina were directed toward the lower end of humeri. In study by Bhojaraja VS *et al.*,[13] mean length of humerus observed in the present study was 30.7 cm. The NF was situated at 17.8 cm from the proximal end, 12.4 cm from the distal end and ~2.9 cm below the mid length of humerus. The mean foramina index and circumference of NF was 57.7 and 6.2 cm respectively. Majority of the humeri (77%) had single NF while in 3% of humeri NF was absent. Middle one-third and on the anteromedial surface of the humerus was the most common location of the foramen. Majority of the dominant foramen was large in size and all were directing toward the distal end. On this basis, having knowledge on the location of the nutrient foramen and the relevant anatomy, the surgeon can prevent a damage to the nutrient artery and can minimize the delayed union or a nonunion of the fracture.

CONCLUSION

The knowledge of the nutrient foramina morphometry is consequently important in various orthopedic surgical procedures, such as joint replacement therapy, fracture repair, bone grafts, vascularized bone microsurgery and also in medico-legal cases.

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