

Study of Nutrient Foramen in Humerus

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ABSTRACT

Introduction

Nutrient foramen is the natural opening present in the middle of the shaft of humerus. It passes the nutrient artery to the medullary cavity. Nutrient artery is the chief artery which enters into the bone through a nutrient foramen to provide nutrition its growth. It plays important role in healing during fracture, trauma and also important for bone grafting.

The objective of study was to identify the number of nutrient foramen in dry humerus and to observe direction and allocation of the nutrient foramina.

Methods

The study was performed in 200 (74 and 126 left) dry humeri. The samples were collected from medical and dental colleges of Nepal in years ranging from August 2018 to January 2020. The length of dry humerus were measured by vernier caliper, needle was used for direction of nutrient foramen.

Results

Out of 200 dry humeri, 143(71.5%) had a single nutrient foramen, 44(22.0%) had double, 9(4.5%) had triple and 4(2.0%) had no nutrient foramen. The majority of nutrient foramen was observed in Anteromedial (91.5%), 5.4% in anterolateral and 1.5% in posterior surface of humerus. The foraminal index 1(0.5%) bone recorded under Zone I, 182(91%) in zone II and 13(6.5%) in zone III. The average foraminal index of bone was 56.18 and the average length of Humerus was 27cm.

Conclusions

The single nutrient foramen was predominant and majority of nutrient foramina were found in anteromedial surface.

Key words: humerus; nutrient foramen; foraminal index; nutrient artery; diaphysis.

INTRODUCTION

Humerus is a typical long bone of arm in human body extends from shoulder to elbow¹. It is very important bone of upper limb with attachment

of major muscles like biceps, triceps and deltoid etc.² which transmits weight from hand, forearm to the axial skeleton through clavicle by the help of coracoclavicular, sternoclavicular ligaments.³

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Nutrient foramen is the small opening present in most of the bone of human body to transmit the nutrient artery which supply nutrition to different part of bone. Normally, nutrient foramen in humerus present near the mid-point of the anteromedial surface of its diaphysis along the medial border^{4,5} but different researches shows it is also presents in other surfaces anterolateral and posterior of humeral diaphysis.⁴ The nutrient artery divided into ascending and descending branch after it reached the medullary cavity of humerus.⁶ Each branch give off small helical branches which form the metaphyseal artery with hair pin loop⁷ has many clinical significance like trauma, orthopedic surgery, fracture repair and bone graft because it supply the metaphysis which is most important and actively growing part of bone.⁸

The study aimed to find out the numbers of nutrient foramen in dry humerus. The study showed the direction of foramina and their allocation according to foraminal index in Humerus. This type of study will aid in forensic department to identify the bone, surgery department for bone graft, medical student to understand the nutrient foramen of humerus with its direction and foraminal index.

METHODS

The study was carried out in 200 dry humeri (74 rights and 126 lefts) collected from medical and dental colleges of Nepal in years ranging from August 2018 to January 2020 AD.

Naturally extracted dry humeri were included in study but artificial, broken, damage humeri were not included in study.

Procedure

The nutrient foramen was observed in all surfaces; anteromedial, anterolateral and posterior surfaces and borders; medial, lateral and posterior of humeral diaphysis and noted in paper as it present either single, double or triple

or more.

Then the direction of nutrient foramen was confirmed by inserting probe (as needle) inside the foramen. Foraminal index was calculated by the given formula i.e. foraminal index equals division of distance from proximal end of Humerus to the nutrient foramen by total length of Humerus and result multiply by 100.^{3,9} The distances from proximal end of Humerus to the nutrient foramen and the total length of humerus were measured by using vernier caliper in mm.

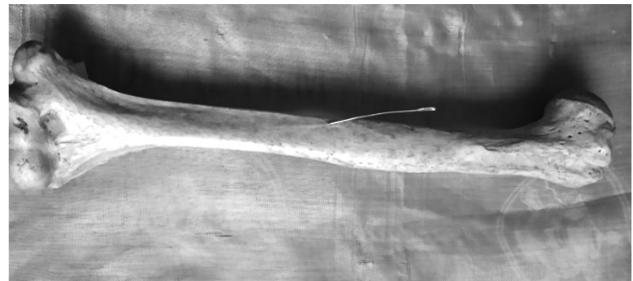


Figure 1. Showing the direction of nutrient foramen with the help of needle.



Figure 2. Showing the measurement of length of humerus from proximal end to the nutrient foramen.

Foraminal index is defined as the distance from proximal end of bone to nutrient foramen divided by total length of humerus which result multiply by 100 as follow.^{3,9}

$$\text{Foraminal index} = \frac{\text{the distance from proximal end of bone to nutrient foramen}}{\text{Total length of humerus}} \times 100$$

According to foraminal index position of nutrient foramen in bone were classified into Zone I, Zone II, and Zone III. Zone I is defined as foramina index below 33.33, Zone II is defined as foraminal index from 33.33 to 66.66, similarly

zone III is defined as the foraminal index above 66.66.

Thus the collected data were entered in Statistical Package for the Social Science (SPSS) 20 to calculate the frequencies and percentages of nutrient foramen, averages length of humerus and foraminal index, and P-value.

RESULTS

The present study showed 258 nutrient foramina in 200 humeri. The single nutrient foramen was present in 71.5% of humeri (87.8% on right and 61.9% on left), double nutrient foramina in 22% of humeri (6.8 % on right and 31% on left), triple nutrient foramina in 4.5% of humeri (5.4% on right and 4% on left) and nutrient foramen was absent in 2% of humeri. Majority of the nutrient foramina (91.5%) were found to be present on the antero-medial surfaces of the shaft of humeri, 5% of the nutrient foramina were concentrated on the anterolateral surface and 1.5% of the nutrient foramina) were located on the posterior surface of the shaft of humeri. The mean foraminal index was 56.18. On the basis of zone, 91% were present in the middle one-third or Zone II of the shaft of humeri, 6.5% were present in Zone III and 0.5% of nutrient foramina were found to be present in Zone I of the shaft of humeri.

The results are shown in following tables.

Nutrient foramen	Right		Left	
	Frequency	Percent	Frequency	Percent
Absence	-	-	4	3.2
Single	65	87.8	78	61.9
Double	5	6.8	39	31.0
Triple	4	5.4	5	4.0
Total	74	100.0	126	100

Surfaces	Right		Left	
	Frequency	Percentage	Frequency	Percentage
Absent foramen	-	-	4	3.2
Anteromedial	68	91.8	115	91.2
Anterolateral	5	6.8	5	4
Posterior	1	1.4	2	1.6
Total	74	100.0	126	100

Zone	Right		Left	
	Frequency	Percentage	Frequency	Percentage
Absence foramen	-	-	4	3.2
I	1	1.4	-	-
II	68	91.9	114	90.5
III	5	6.8	8	6.3
Total	74	100.0	126	100

DISCUSSION

The recent study was performed to determine the number of nutrient foramen in Humerus. In the present study the single nutrient foramen were present in 71.5% of humeri which was contrast to Yaseen et al.¹⁰ (88.5%), Khan et al.¹¹ (90.67%), and almost similar to Chandrasekaran et al.¹²(76.74%), Anusha et al.¹³(72%), Parmar et al.¹⁴(72%), Muralimanju et al. (93.8),¹⁵ Kizilkananta et al.¹⁶(68.32%), Carrol et al.¹⁷(67.61%). The nutrient foramen were located predominantly on antero-medial surface depicted by the study of Mansur et al.³ (88.86%), Chandrashekharan et al. (89.92%) supported 91.5% of present study and different from Solanke et al.¹⁸ reported only 67%. The prevalence of double nutrient foramen was found to be 22% and triple nutrient foramen was 4.5 % in the recent study. Similar findings were present in the study investigated by Chandrasekaran et al.

(20.54% and 2.71%), Parmar et al. (21.67% and 3.33%). About 2% of humerus didn't show the presence of nutrient foramen which corresponds to the study performed by Mansur et al. (1.98%) and Kizilkananta et al. (1.98%). The present study also reported that the mean foraminal index was 56.18% with the similar findings by Ukoha et al.¹⁹ (56.28%), Pereira et al.²⁰ (55.2%). The nutrient

foramina were mainly situated in the middle 1/3rd or zone II of the humerus (91%).

Studies conducted by Mansur et al. (94.84%), Solanke et al.¹⁸(90%), Yaseen et al.(89%) also showed the higher incidence of position of nutrient foramen in Zone II. However there is less incidence of nutrient foramen present in Zone I (0.5%) with the similar result conducted

Table 4. Comparison of number of nutrient foramen in different studies.

Author	Year in AD	Sample size	Single %	Double %	Triple %	Four %	Absence %
Present study	2020	200	71.5	22	4.5	-	2
Mansur et al. ³	2016	253	60.87	28.85	6.32	1.98	1.98
Khan et al. ¹¹	2014	75	90.67	9.33	-	-	-
Chandrasekaran et al. ¹²	2013	258	76.74	20.54	2.71	-	-
Anusha et al. ¹³	2013	50	72	24	-	-	4
Parmar et al. ¹⁴	2011	60	75	21.67	3.33	-	-
Muralimanju et al. ¹⁵	2011	243	93.8	3.1	-	-	3.1
Kizilkananta et al. ¹⁶	2007	101	68.32	21.78	6.93	0.99	1.98
Yaseen et al. ¹⁰	2014	100	79	19	2	-	-
Forriol et al. ⁵	1987	36	75	25	-	-	-
Carroll et al. ¹⁷	1963	71	67.61	28.16	4.23	-	-

Table 5. Shows percentage of nutrient foramen present in different surface by various studies.

Author	Year in AD	Sample size	AM	AL	Posterior
Present study	2020	200	91.5	5	1.5
Mansur et al.	2016	253	88.86	6.52	4.62
Solanke et al. ¹⁸	2014	100	67	32	1
Yaseen et al.	2014	100	88.5	3.5	8
Chandrashekharan et al.	2013	358	89.92	1.55	8.53

Note: AM: Anteromedial, AL: Anterolateral

Table 6. Distribution of nutrient foramen according to foraminal index.

Author	Year in AD	Sample size	Zone I %	Zone II %	Zone III %
Present study	2020	200	0.5	91	6.5

Mansur et al.	2016	253	0.54	94.84	4.62
Solanke et al.	2014	100	4	90	6
Yaseen et al.	2014	100	-	89	11
Chandrashekharan et al.	2013	358	-	86.43	13.57

Table 7. Mean foraminal index in different studies.

Author	Year in AD	Sample size	Foraminal index
Present study	2020	200	56.18
Mansur et al.	2016	253	55.20
Solanke et al.	2014	100	52.65
Ukoha et al. ¹⁹	2013	150	56.28
Pereira et al. ²⁰	2011	174	55.2

Table 8. Discuss on direction of nutrient foramen in percentage.

Author	Year in AD	Sample size	NF	DD	DP	DH
Present study	2020	200	258	98.47	-	1.53
Mansur et al.	2016	253	736	100	-	-
Yaseen et al.	2014	100	139	99.2	-	0.8
Kumar et al. ²¹	2012	23	233	99.54	-	0.46
Khan et al.	2014	75	109	97.06	2.94	-

Note: NF: Number of nutrient foramen, DD: Directed to distal end of Humerus, DP: Directed to proximal end of Humerus, DH: Directed horizontally

by Mansur et al.(0.54%). The nutrient foramen directed downwards recorded was 98.47% and 1.53% of nutrient foramen were directed horizontally. A study conducted by Yaseen et al. showed similar finding that 99.2% foramina were directed downward and 0.8% foramina were directed horizontally, Kumar S. et al.²¹ reported 99.54% directed downward and 0.46% directed horizontally. There was only difference of about 1% in both foramina directed downward and horizontally.

In the study of Ara et al.²² p-value is not significant at p=0.319 in presence, absence, number, location and position of nutrient foramen in male and

female left dry humeri. The present study showed p-value as 0.05 which showed that significant among presence, absence, number, location and position of nutrient foramen did exist. The study by Bokariya et al.²³ showed not significant at p>0.05 which was difference from Ara et al and present study. The overall discussion was shown in table 4-6 from different researcher.

Nutrient artery enters through nutrient foramen present in bone and the damage to nutrient artery may lead to delayed union following fracture of shaft of humerus.¹¹ The knowledge about the position of nutrient foramen will be helpful for

orthopedic surgeon to minimize the damage to nutrient artery during surgical procedures.

CONCLUSIONS

The study showed more numbers of single nutrient foramina present in anteromedial surface of Humerus directed downward. Most

of the nutrient foramina located on the Zone II according to the foraminal index.

These type of study will help in surgical procedure of fracture, trauma and will give knowledge about variation of nutrient foramen present, so that operator may not confused during operation.

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Citation: Sintakala C, Manandhar M. Study of Nutrient Foramen in Humerus. *JCMS Nepal.* 2020; 16(4):252-58.