



STUDY OF NUTRIENT FORAMINA OF ADULT HUMERII IN SOUTH INDIAN POPULATION

Anatomy

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ABSTRACT

INTRODUCTION: Fracture of long bones is very common and major complications of these fractures are non-union and delayed union. There are various reasons for these complications and its blood supply plays an important role. Blood supply of long bones is mainly by nutrient artery. This study was aimed at analysing the nutrient foramina in dry adult humerii.

MATERIAL AND METHODS: The following parameters were noted; the length of the humerus, the number and its location with respect to the surfaces, and its distance from the mid-point of the humerus. All the data were noted and the statistical analysis was done by calculating the mean, the range and the standard deviation.

RESULTS: Out of 100 humerii studied, 92 % had single nutrient foramina and 8% showed double nutrient foramina. The nutrient foramina of the humerii were not only located on the anteromedial surfaces but also on the anterolateral and the posterior surfaces. Similarly, the nutrient foramen of the humerus was found on both the middle and the lower third of the shaft.

CONCLUSION: The precise anatomical knowledge of the nutrient foramen of the long bones of upper limb is important for orthopaedic surgeons during surgical procedures like bone grafting, microsurgical bone transplantation.

KEYWORDS

Nutrient foramen, Humerus, Nutrient artery

INTRODUCTION:

Humerus is the largest bone of upper limb so it also enjoys highest vascularity among the bones of upper limb. Blood supply is mainly by brachial artery and also by axillary, radial and ulnar arteries. The periosteal and metaphyseal arteries supply the outer cortex and metaphysis of bone and the inner half of cortex and medulla depend upon nutrient artery for blood supply. The long bone of the arm, humerus is supplied by a nutrient artery, which enters the bone obliquely through the nutrient foramen, which is directed away, as a rule, from the growing end¹⁷. Nutrient foramen is an opening into shaft of humerus which gives passage to the blood vessels of medullary cavity. It is well known that nutrient artery seek the elbow and flee from the knee¹⁹. This is because one end of limb bone grows faster than the other do. Henderson.R.G, reported that their position in mammalian bones are variable and may alter during the growth⁷. The knowledge of nutrient foramen is important in surgical procedures like bone grafting and more recently in microsurgical vascularized bone transplantation.

METHODS:

The study sample consisted of 100 adult humerii (dry bones) available in the Department of Anatomy, Srinivas Institute of Medical Sciences and Research centre, Mukka, Mangalore selected by convenient sampling irrespective of age and sex over a period of 8 months. Length and width of the humerii were measured and noted using measuring tape and scale. Length of the humerus was measured from upper end of lesser tubercle to lower border of medial epicondyle using measuring scale and tape. Epicondylar width was measured using Vernier digital calipers. The midpoint of the humerus was calculated by dividing the length of the humerus by two and the same was identified and marked on the humerus with the help of the measuring tape. The location of the nutrient foramen was noted with respect to the three surfaces, namely, the anteromedial, the anterolateral and the posterior. All the bones were macroscopically observed for the number and location of the nutrient foramina.

Only diaphysial nutrient foramina were observed in all the bones. A 24-gauge needle was passed through each foramen to confirm their patency. All the data were noted and the statistical analysis was done by calculating the percentage, mean, range and the standard deviation (SD).

FIGURE 1: Method of measurement of length of humerus from the upper end of lesser tubercle to lower border of medial epicondyle



RESULTS:

Totally 100 adult dry humerii were studied, of which 58% were left sided bones and 42% were right sided bones. The mean length of the humerii was 30.29 cm, with a SD of 1.61cm, which ranged from minimum 27cm to maximum up to 34 cm on the right side and mean length of left humerii was 29.49 cm, with a SD of 2.37cm, which ranged from minimum 20.5cm to maximum up to 34 cm. (TABLE 1)

The nutrient foramina of the humerii were not only located on the anteromedial surfaces but also on the anterolateral and the posterior surfaces. Similarly, the nutrient foramen of the humerus was found on both the middle and the lower third of the shaft. In the present study, out of 100 humerii (42 right and 58 left), 92% of the humerii had single nutrient foramen. The double foramen was observed in 8% of the cases. 87 humerii (39 right and 48 left) showed the foramina at the antero-medial surface, 10 humerii (3 on right and 7 on left) at the medial border, one each at the anterior border (left), anterolateral surface (left) and at posterior surface (left) (TABLE 3). The morphological and topographical distribution of the foramina of humerus is represented in TABLE 5.

The distance of the dominant nutrient foramen from the midpoint of the humerus ranged from 0.5-6 cm on the right humerii, with a mean distance of 2.66 cm and a SD of 1.26 cm and 0-6cms on the left humerii with a mean distance of 2.63 cm and a SD of 1.37 cm (TABLE 2).

97.6% of the nutrient foramina were located below the midshaft and 2.4% on the midshaft of the right humeri, and 94.8% were located below the midshaft, 1.7% above the midshaft and 3.4% on the midshaft of left humeri. (TABLE 4).

TABLE 1: Morphometry of Humerus

HUMERUS Right side	LENGTH (cms)	EPICONDYLAR BREADTH (cms)	MIDSHAFT CIRCUMFERENCE (cms)
MEAN	30.29	5.57	6.12
SD	1.61	0.50	0.59
MINIMUM	27	4.00	5.00
MAXIMUM	34	6.80	7.50
TOTAL	42	42	42
HUMERUS Left side	LENGTH (cms)	EPICONDYLAR BREADTH (cms)	MIDSHAFT CIRCUMFERENCE (cms)
MEAN	29.49	5.52	6.07
SD	2.37	0.49	0.71
MINIMUM	20.5	4.3	4.5
MAXIMUM	34	6.8	8.0
TOTAL	58	58	58

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TABLE 2: Distance of nutrient foramen measured from midshaft level

	Side	No. of humerus	Minimum distance in cms	Maximum distance in cms	Mean distance in cms	Std. deviation
Nutrient foramen	Right	41	0.5	6.0	2.66	1.26
	Left	55	.0	6.0	2.63	1.37

TABLE 3: Location of nutrient foramen in humerus

	Location	No of humerus	Percent
Right	Anteromedial surface	39	92.9
	Medial border	3	7.1
	Total	42	100
Left	Anteromedial surface	48	82.8
	Anterolateral surface	1	1.7
	Anterior border	1	1.7
	Medial border	7	12.1
	Posterior surface	1	1.7
	Total	58	100

TABLE 4: Level of nutrient foramen with respect to midshaft

Right	No of humerus	Percent
Below the midshaft	41	97.6
Midshaft	1	2.4
Total	42	100
Left	No of humerus	Percent
Below the midshaft	55	94.8
Above the midshaft	1	1.7
Midshaft	2	3.4
Total	58	100

TABLE 5: Morphological and topographical distribution of the nutrient foramina in the humerus (n=100)

No of nutrient foramina	Right side	Left side	Total	%
1	39	53	92	92
2	3	5	08	08
Total	42	58	100	100

DISCUSSION:

The humerus is supplied by the nutrient artery, the metaphyseal artery and the periosteal vessels from the axillary and the brachial arteries and their branches. The periosteal and the metaphyseal arteries supply the outer cortex and the metaphysis of the bone, but the inner half of the cortex and the medulla of the shaft are predominantly dependent on the nutrient artery. The study on the blood supply of the shaft will help in knowing about the healing of fractures, delayed unions and non-unions of the bone following fractures and bone transplants²¹. Laing studied the vascularity of the humerus and he opined that the main nutrient artery of the humerus must be protected from injuries during operations which are done on the humeral shaft¹². Carroll stated that the nutrient artery enters through the restricted anteromedial surface, in the middle 1/3rd of the humerus and that the surgeries which are done

on the middle 1/3rd of the shaft of the humerus should be handled well without causing damage to the nutrient foramen, in order to prevent delayed unions or non-unions of the fractures. In a study done by Shanta Chandrasekaran et al on 258 humeri, 198 (76.74%) humeri had single nutrient foramen while 53 (20.54%) had two nutrient foramina and only 7 (2.71%) humeri had three nutrient foramina². Manjunath SH et al¹⁴ studied 200 humeri and reported 161 (80%) single nutrient foramen, 35 (18%) double nutrient foramina and 4 (2%) showed triple nutrient foramina. Laing PG et al¹² reported 28 (93%) humeri with one nutrient foramina and 2 (7%) humeri with two nutrient foramina out of 30 humeri studied. Our study results correlated well with those of Laing study. In several studies which have been done on the humerus have revealed that a majority of the humeri had one nutrient artery and that some which had additional accessory arteries had more than one nutrient foramen.

TABLE 6: Comparison of various studies with regard to number of nutrient foramina in humerus

	Carroll	Manjunath and Pramod	Hamang Joshi	P.G. Laing	Shantha C	Present study
Number of humeri analysed	71	200	200	30	258	100
Humerus with single nutrient foramen	48 (68%)	161 (80.5%)	126 (63%)	28 (93%)	198 (76.74%)	92 (92%)
Humerus with double nutrient foramen	20(28%)	35(17.5%)	66(33%)	02(07%)	53(20.54%)	08(8%)

The external opening of the nutrient canal, usually referred to as the nutrient foramen, has a particular position for each bone²⁰. Longia GS et al¹³ observed that the position of nutrient foramina was on the flexor aspect in their human long bone specimens. It is generally agreed that the vessels which occupy the nutrient foramen are derived from those that took part in the initial invasion of the ossifying cartilage, so that the nutrient foramen was at the site of original centre of ossification²⁰. Patake SM and Mysorekar VR¹⁹ opined that the number of foramina do not seem to have any significant relation to the length of the bone. They described that the number of foramina may not have relation to the number of ossification centres, because the femur, which is having one primary centre, usually has two foramina and clavicle, with two primary centres, has generally a single foramen. It was suggested that the direction of nutrient foramina is determined by growing end of the bone. The growing end is supposed to grow at least twice as fast as the other end¹⁸. The well-known factors, which may affect nutrient foramen position, are the growth rates at the two ends of the shaft and bone remodeling⁷. Lacroix P¹¹ suggested that the pull of muscle attachments on periosteum explained certain anomalous nutrient foramina directions. Nutrient arteries, which are the main blood supply to long bones, are particularly vital during the active growth period and at the early phases of ossification¹⁰. These nutrient arteries pass through the nutrient foramina, the position of nutrient foramina in mammalian bones are variable and may alter during the growth¹. In humerus, the nutrient artery usually arises either from the brachial artery or from the profunda brachii artery as one or more branches or from the muscular branches of these arteries. The double foramina in humerus would suggest that one of them would be the main foramen and the other accessory one and hence the nutrient artery can arise either from the brachial or profunda brachii artery¹⁸. According to Mysorekar VR¹⁸, humerus usually has two nutrient foramina and they occur just below the middle part of the bone or in the radial groove or frequently in both these locations. Manjunath¹⁴ concluded in his study that nutrient artery to the humerus enters through the anteromedial surface of middle 1/3rd of shaft. He found 87% of nutrient foramina on anteromedial surface and 84% on middle 1/3rd of humerus.

This study concludes that the nutrient foramina of the humeri were not only located on the anteromedial surfaces but also on the anterolateral and the posterior surfaces. Similarly, the nutrient foramen of the humerus was found on both the middle and the lower third of the shaft. A majority of the humeri had a single nutrient foramen, though some humeri had more than one nutrient foramen.

CONCLUSIONS

This study provides an information on morphology and topography of nutrient foramina in humerus which is of great use to orthopaedic

surgeons to treat fractures of humerus and also to minimise complications of this treatment. The anatomical data of this subject is helpful to the clinician as the microvascular bone transfer has become more popular. Observations made in this study make it quite evident that entry of nutrient artery is restricted to anteromedial surface on middle 1/3rd of humerus. So one has to be careful to guard nutrient artery against any injury, especially in this area during surgeries on humerus.

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