A Study of The Nutrient Foramina Of The Humeral Diaphysis

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Abstract : Non-union of the humeral shaft remains a difficult clinical problem and it may appear after any method of treatment; closed or open reduction. For this reason the precise location of nutrient foramen of humerus and relevant anatomy should be known. The anatomy of the nutrient foramina of humeral diaphysis has been studied in 200 human humeri. Measurements were taken with the help of osteometric board and observations were noted. In present study 77% foramina were found medially; on ulnar border & anteromedial surface (zone A & B). The mean position of nutrient foramen lies distal to the mid-point of humerus (mean 1.5 cm distal, vertical zone III). Of 200 humeri, 63% had a single nutrient foramen which implies that the major blood supply to humeral shaft will enter at one particular point. Knowledge of the anatomy of nutrient foramina is significantly important for orthopaedic surgeons doing open reduction of fracture mid shaft humerus, in order to avoid injuring nutrient artery & thereby lessens the chances of delayed or non-union of fracture shaft humerus.

Key-words: nutrient foramina, nutrient artery, humeral diaphysis

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INTRODUCTION: The biologic process of repair of a traumatic or surgically induced interruption in the continuity of bone may develop slowly or not at all[1]. One of the causes of delayed union or non-union in fracture is loss of blood supply & this emphasizes the major role of medullary arterial system in supplying blood to uniting callus & in revascularizing necrotic cortex of fracture site[2]. Fracture non-union in humerus may appear after any method of treatment; closed reduction or open reduction. For this reason, the precise location of nutrient foramen of humerus & relevant anatomy should be known. By defining this restricted area of nutrient artery entering into nutrient canal, surgeons can avoid that during surgical operations & thereby prevent damage to nutrient artery & minimize or lessen the chances of non-union & delayed union of fracture shaft humerus[3].

MATERIAL AND METHODS: 200 humeri, not necessarily paired, of unknown age & sex were examined from the collection of Anatomy department of various medical colleges of Gujarat. Observations taken in the study were length of humerus, relation of nutrient foramen to mid-point of humerus, position of nutrient foramen in relation to borders & surfaces of humerus and size of nutrient foramen. The length of each labelled humerus was measured using osteometric board. Length was measured from superior aspect of lesser tuberosity to the inferior surface of medial epicondyle [3].

Foramina within shaft, excluding minute openings were recorded, together with their position relative to borders & surfaces of humerus as described in Gray's anatomy[4.] Foramina within 2 mm from border were classified as being on that border[3].

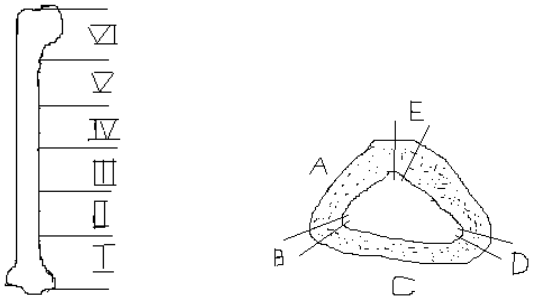
Vertical zones of shaft were defined by dividing the measured length into sixths. Zone – I, II, III, IV, V, VI (starting from lower end of humerus to upper end of humerus) [3]

The foramina recorded were grouped into these vertical and horizontal zones. The size of nutrient foramen was determined by using hypodermic needle No. 20 & No. 24 (Eastern Medikit Limited) [3].

Large foramen – accepted the No. 20 needle
Medium foramen – accepted only the No. 24 needle
Small foramen – did not take No. 24 needle
When more than one foramen was present, the larger one was considered Dominant[3]. Observations

thus made were compiled, tabulated and appropriate statistical analysis were done by calculating the standard deviation and using Fisher's "t" table, or by calculating the standard error of the difference between proportions.

A : Vertical Zone, B: Horizontal Zone



A B

Horizontal zones[3], categorized in relation to border & surfaces of shaft of humerus, are as follows:

Zone A – Anteromedial surface
Zone B – Ulnar (medial) border
Zone C – Posterior surface
Zone D – Lateral border
Zone E – Anterior border

RESULTS: Number of nutrient foramina: One per bone – 126, Two per bone – 66, Three per bone – 08. Table I shows distribution of nutrient foramina of humerus in vertical and horizontal zones. According to this – 77 % of foramina were medial side(zone A & B), 22 % of foramina were lateral side(zone C & D). 30 out of 62 lateral foramina were in the musculo-spiral groove. There is high tendency (94 %) of medial foramina to lie distal to mid-point of humerus (vertical zone III).

TABLE – I: Nutrient foramina of humerus in vertical & horizontal zone

Zones		Horizontal					
		A	B	C	D	E	Total
Vertical	VI	0	0	0	0	0	0
	V	0	0	8	2	0	10
	IV	4	8	10	34	0	56
	III	66	120	0	8	4	198
	II	4	12	0	0	0	16
	I	0	2	0	0	0	2
	Total	74	142	18	44	4	282

Table II shows distribution of dominant foramina of humerus in vertical and horizontal zone. There is a statistically significant ($p < 0.01$) tendency for the dominant foramina to be medial (90 %) and distal to mid-point (87 %). There is a highly significant ($p < 1$ per cent) tendency for the medial foramina to be dominant (83 %). Comparison with Table I show that the proximal & lateral foramina tend to be secondary.

Table-II: Dominant nutrient foramina of humerus in vertical & horizontal zone

Zones		Horizontal					
		A	B	C	D	E	Total
Vertical	VI	0	0	0	0	0	0
	V	0	0	0	2	0	2
	IV	4	8	2	10	0	24
	III	60	96	0	4	2	162
	II	4	8	0	0	0	12
	I	0	0	0	0	0	0
	Total	68	112	2	16	2	200

Table-III shows that 126 humeri had single nutrient foramen. Out of that, 116 foramina were medial (92 %).

Table-III: Single nutrient foramina of humerus in vertical & horizontal zone

Zones		Horizontal					
		A	B	C	D	E	Total
Vertical	VI	0	0	0	0	0	0
	V	0	0	0	2	0	2
	IV	2	4	0	2	0	8
	III	44	60	0	4	2	110
	II	2	4	0	0	0	6
	I	0	0	0	0	0	0
	Total	48	68	0	8	2	126

DISCUSSION: The healing of fractures, as of all wounds, is dependent upon blood supply[4, 5, 6.] Injury to nutrient artery at the time of fracture or at subsequent manipulation may be a significant factor predisposing to faulty union [7, 8,9,10, 11]. Non-union of humeral shaft remains a difficult clinical problem. If surgeons could avoid a limited area of cortex of humerus containing nutrient foramen, particularly during open reduction, an improvement in management of this problem might be attained.

Fig. 1 Length of Humerus from superior border of lesser tuberosity to inferior surface of medial epicondyle

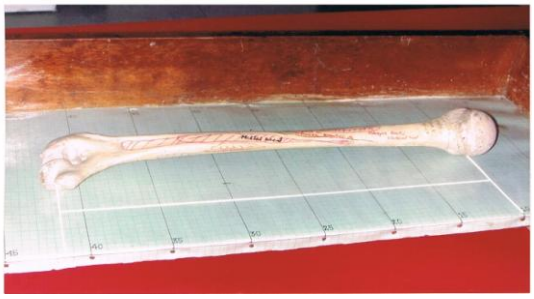


Fig. 2 Distance of nutrient foramen from mid-point of humerus

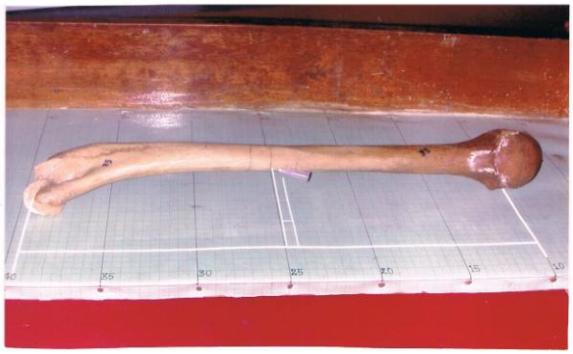


Fig. 3 Nutrient foramina of large (yellow, No.20 G needle) and medium (purple, No.24 G needle) size in the humerus

This study shows that the mean position of nutrient foramen lies distal to mid-point of humerus (mean 1.5 cm distal, vertical zone III), which matches with the study of S. E. Carroll[3] who has noted the same with mean 1.0 cm distal to mid-point of humerus. P. G. Laing[7] has observed the point of entry along length of shaft at the junction of middle and lower third or in the lower part of middle third in 80 % of cases; around the mid-point in 13 % and at junction of third and fourth quarters of shaft in 7 % bones. So it suggests that the danger of damaging nutrient artery will probably greatest in open reduction of fracture of mid-shaft humerus and fracture through the shaft at junction of middle and lower third will probably destroy main nutrient artery at time of injury.

TABLE IV- Numbers of nutrient foramina in humerus

	S.E CARROLL[3]	P. G. LAING[7]	PRESENT STUDY
Total Humeri studied	71	30	200
Humerus with 1 nutrient foramen	48 (68%)	28 (93%)	126 (63%)
Humerus with 2 nutrient foramina	20 (28%)	2 (7%)	66 (33%)
Humerus with 3 nutrient foramina	3 (4%)	--	8 (4%)

Table IV of comparative studies shows that the major blood supply to humeral shaft will enter at one particular point and special care should be taken not to disturb this area during surgery. Table V suggests that fracture of proximal third or distal third of shaft humerus rarely jeopardize the blood supply.

TABLE V Position of nutrient foramina in relation to length of humerus

Location of dominant nutrient foramen on shaft humerus	S.E CARROLL[3]	PRESENT STUDY
Proximal third of shaft humerus	0	1
Lateral aspect of distal third of shaft humerus	0	0

Table VI of comparative studies shows the tendency of nutrient foramina found medially on shaft humerus. If dominant foramina are considered separately, this proportion is increased to 90%, matches with observation of S. E. Carroll[3] (87%). This strong medial tendency should be duly considered by surgeons during surgical manipulation in fracture shaft humerus and may perhaps give alternative to lateral approach.

Table VII shows the nutrient foramina found laterally on shaft humerus (zone C & D) in different studies. In present study 30 nutrient foramina (48%) were found in musculo-spiral groove which nearly resembles with observation of S. E. Carroll[3] (58%).

So, simultaneous injuries to radial nerve and to vascular supply of humeral shaft would seem unlikely, as these foramina (lateral group) are tended to be secondary and proximal.

TABLE VI Nutrient foramina founds medially(zone A & B) on shaft of humerus

	S.E CARROLL[3]	P. G. LAING[7]	PRESENT STUDY
Nutrient foramina found medially on shaft humerus	74 %	87 %	77 %

TABLE VII Comparative study of nutrient foramina found on lateral side

	S.E CARROLL[3]	P. G. LAING[7]	PRESENT STUDY
Nutrient foramina found laterally on shaft humerus	24 %	20 %	22 %

The present study stresses the fact that the constancy of main nutrient artery of humeral shaft is remarkable as most nutrient foramina were concentrated in a small area on medial aspect of distal half of middle third of shaft. Now it would appear from these observations that one has to be careful to guard against injuring this vessel in operations on humeral shaft. The danger of damaging this artery will probably greatest in open reduction of fracture mid-shaft humerus. So if surgeons emphasize great care to avoid this limited area during operations, there will be least chances of delayed or non-union of fracture shaft humerus.

CONCLUSION: It is evident that nutrient foramina of humerus were most concentrated in a small area on medial aspect of distal half of middle third of shaft. The site of entrance of main nutrient artery to humerus is restricted to an area beginning on medial side of distal third and spiralling proximally and medially to dorsal surface of middle third of shaft. In clinical cases it should be assumed that the major blood supply to the humeral shaft will enter at one point. Non-union commonly occurs in this region. So this region should be avoided if possible during surgical operations for effective management and perhaps for that one should go for lateral approach.

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