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STUDY OF VASCULAR FORAMINA OF HUMERUS IN CENTRAL KARNATAKA POPULATION

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ABSTRACT

Background: The humerus forms the longest bone of appendicular skeleton of upper limb. The nutrient arteries form major blood supply to the long bones, which enters the bone through the nutrient foramina.

Materials and Methods: The present study was undertaken on 200 dry normal adult humerus bone obtained from the Department of Anatomy, SSIMS & RC, Davangere. 100 humeri belong to right and 100 belong to left side.

Results: After the completion of this particular study on the vascular foramina, especially the nutrient foramina on 200 dry humeri, it was able to arrive at following conclusions: Among the segments, upper end shows maximum density of vascular foramina indicating the highest intensity of blood supply. The shaft being, supplied mainly by nutrient artery, the location and direction of nutrient foramina was thus important to find out. The position of nutrient foramina in most cases is found to be in the middle 1/3rd of the anteromedial surface of the shaft and the direction of nutrient foramina was towards the elbow. Middle 1/3rd of anteromedial surface is more vulnerable to surgical or traumatic injuries that may damage nutrient artery, thus highlights its significance.

Discussion and Conclusion: Nutrient foramina plays vital role in nutrition and growth of the bones. Majority of the nutrient arteries follow the rule, 'to the elbow I go, from the knee I flee' but they are very variable in position. Their number, location, direction & its importance in the growing end of long bones were studied in the long bones of upper limb. The present study has variations in the position & direction. The study of nutrient foramina is important for surgeons operating on humerus, it is not only of academic interest but also in medico-legal practice in relation to their position. The present study also emphasizes importance of length of humerus. With the observation and information of variations in the vascular foramen, placement of both external and internal fixation devices on humerus can be appropriately done.

KEY WORDS: Humerus, Nutrient foramen, Diaphysis, Epiphysis.

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INTRODUCTION

The humerus is longest and largest bone of upperlimb, it has expanded ends and a shaft. The proximal round end forms the shoulder joint while the lower extremity is flattened from before backward, and curved slightly forward; it ends below in a broad, articular surface. The shaft is almost cylindrical in the upper half of its extent, prismatic and flattened below [1]. Humerus, being a long bone, gets nourished by following arterial systems- nutrient artery, diaphyseal, epiphyseal and periosteal arteries.

V.R Mysorekar, 1967, examined diaphyseal nutrient foramina of 179 humeri. Out of which 75 had more than one foramen. He also noted that 41% of the nutrient foramina were found on the anteromedial surface, 40% on the medial border and 19 % in the spiral groove. The reciprocity of sizes of the foramina was observed, i.e. if the foramen on the anteromedial surface or medial border was larger, than that in the spiral groove or vice-versa. Size of the foramina of younger bones was larger. The diaphyseal nutrient foramina in humerus may be two in number [2].

Carroll S.E, 1963, studied nutrient foramina of 71 adult humeri. He noted that the maximum number of foramina is concentrated on the small area on the medial aspect of middle third of the humerus. This region is a common site of non-union [3].

Therefore, it is essential to find the position and number of the vascular foramina. An understanding of position and number of foramina is important in orthopedic surgical procedures such as joint replacement therapy, fracture repair, bone graft and vascularized bone microsurgery [4].

Kate B.R, 1971, studied nutrient foramina of long bones and found that constant nutrient foramina was observed in all humeri, just below the insertion of deltoid, on the supracondylar ridge, a little below the midpoint of the shaft and was directed towards elbow. A record foramen was noted on the ridge between coronoid and radial fossae anteriorly, and was having the same direction as that of the nutrient foramen. Number of vascular foramina was observed to be two or more over surgical neck, three or more in the floor of bicipital groove, three or more over the greater tuberosity and two or more posteriorly towards the head. These foramina have a role to play in avascular necrosis in some cases of fractures [5].

Most of the long bones , one end grows much more than the other resulting in the slant of nutrient canal from the surface to marrow cavity is towards the end that grow less rapidly. Meanwhile, the ends of the long bone usually have many arteries entering them and many veins leaving, so that several vascular foramina are usually visible at the ends of a dry bone [6].

The nutrient artery, a branch of brachial artery, enter the shaft of humerus near the insertion of coracobrachialis tendon, thus exposing itself to damage with some distal shaft fractures or internal fixation and possible predisposition to non-union in the fractures of the middle or distal thirds [7].

As there is scanty data available about the exact location of vascular foramina, the current study attempts to evaluate the pattern of vascularity of humerus in terms of specific sites in the population of Central Karnataka.

MATERIALS AND METHODS

The present study was undertaken on 200 dry normal adult humerus bone obtained from the Department of Anatomy, SSIMS & RC, Davangere. 100 humeri belong to right and 100 belong to left side.

Humerus was divided into different segments. Distribution of foramina was studied in these segments.

Study was carried out with Hepburn's Osteometric board, Marker pen, 19, 22, 25 gauge needles.

The following observations were worked out:

1. The number and distribution of vascular foramina in each segment (upper end, shaft and lower end) was noted.

2. The size of vascular foramina in each segments were measured. They were categorized based on size i.e., Minimum- 0.5 to 0.71 mm, Average- 0.71 to 1.00 mm and Maximum->1.10 mm.

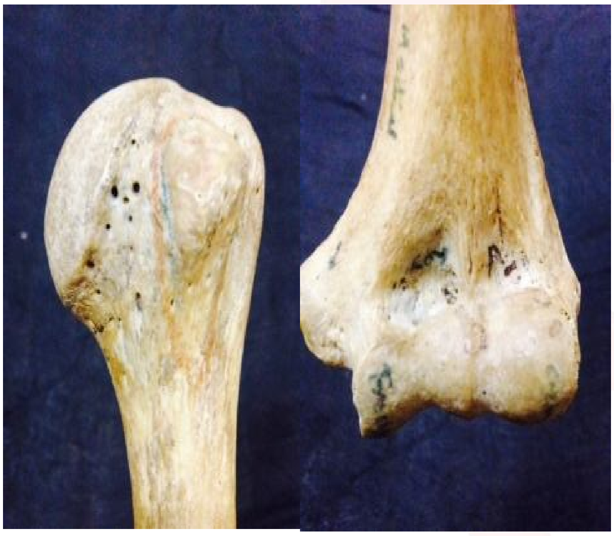
3. The foramina which admitted 19 gauge needle were considered to be greater than 1.10 mm, those admitted 22 gauge needle were 0.71 to 1.00 mm and those admitted 25 gauge needle were 0.5 mm to 0.7 mm.

3. The direction of foramina in each segments were noted. They were categorized into three types: Straight, Upper Oblique and Lower Oblique.

The number of nutrient foramen in each segment (anteromedial, anterolateral, and posterior surface) of shaft was noted. Size of each of these was measured. Its direction and location was noted.

Fig. 1: Showing two diaphyseal nutrient foramen.

Fig. 2: Showing the vascular foramen of upper end & lower end of left humerus.



OBSERVATIONS AND RESULTS

Distribution of vascular foramina:

Table 1: Average number of vascular foramina in each segment.

Segments	Average number of vascular foramina	Min-Max	SD
Upper end	3.45	0-7.8	2.66
Shaft	0.43	0.02-1.1	0.58
Lower end	2.04	0-5.42	1.81

Size of vascular foramina:

Table 2: Average size of the vascular foramina in each segments.

Segments	≥0.5<0.71 mm	≥0.71<1.1 mm	≥1.1 mm
Upper End	1.41	1.15	0.59
Shaft	0	0.03	0.4
Lower End	0.84	0.76	0.34

Direction of the foramina:

Table 3: Direction of foramina in each segments of the bone.

	Upper End	Shaft	Lower End	Mean	%
Straight	2.1	0	1.08	1.06	54
Upper Oblique	0.96	0	0.61	0.52	26
Lower Oblique	0.39	0.43	0.35	0.39	20

No. of nutrient foramina:

Table 4.1: No. of Nutrient foramina.

No. of nutrient foramina	Total no. of humerus	Percentage
0	0	0
1	148	74
2	48	24
3	4	2
Total	200	100

Size of nutrient foramina:

Table 4.2: Size of nutrient foramina.

Size of nutrient foramina	Total No. of Nutrient foramina	%
≥0.5<0.71 mm (Min)	0	0
≥0.71<1.1 mm (Avg)	24	9
≥1.1 mm (Max)	240	91

Location of nutrient foramina:

Table 4.3: Location of nutrient foramina in different surfaces of the shaft.

Location of nutrient foramina	Number of Nutrient foramina	Percentage
Anteromedial surface (Am)	220	83.33
Anterolateral surface (Al)	4	1.5
Posterior surface (Ps)	40	15.15

Distribution of vascular foramina over different sections of the humerus: According to the observations, (Table 1) the average distribution of vascular foramina over the upper end is maximum of 3.45 while it is minimum in shaft with an average of only 0.43.

Size of the vascular foramina: The foramina are grouped into minimum, average and maximum. Upper end having foramina of all size. Lower end in turn had maximum number of small sized foramina. Foramina of shaft are mostly large sized (Table 2).

Direction of vascular foramina: While observing the direction was found to be straight in 54% of foramina. (Ref. Table 3). It also was observed that the direction of foramina with respect to each segment showed variation. Upper end showed more number of straight foramina while shaft presented with foramina placed obliquely towards distal end. Lower end presented with almost equal number of foramina of all directions (Table 3).

Nutrient foramina

Number: Among the 200 humeri 148 had single foramen, 48 showed two foramina while rest showed three foramina. i.e., 74% of the humeri had single foramen while 24% had two only 2% had three foramina. Bone without nutrient foramina was not observed (Table 4.1).

Size: 91% of the nutrient foramina were large sized while 9 % is medium sized (Table 4.2).

Location: 83.33% of nutrient foramina were observed in the a1nteromedial surface of the shaft (Table 4.3).

Direction: The direction of nutrient foramina observed in all cases to be lower oblique and is directed towards elbow. No variation as such is noted.

DISCUSSION

Humerus being the longest bone of the upper limb is highly vascularized by branches of axillary artery and brachial artery. The upper end showed an average number of (mean) 3.45 vascular foramina, of all size (majority being large sized), indicating high vascularity of this segment in comparison with the other two. This is in accordance with previous studies regarding the blood supply of upper end of humerus [8,9]. It shows that, there is abundant extraosseous and intraosseous anastomosis in the upper end of the bone.

Our observations revealed that the floor of bicipital groove had significant number of vascular foramina. This result is consistent with Brookes, 1993; et al, the role of ascending branch of anterior circumflex humeral artery on supplying humeral head, as the artery courses in the floor of bicipital groove [8]. On the other hand, Menck J 1997, stated that the humeral head is supplied by anastomosis of anterior and posterior circumflex humeral artery [9]. But Hettrich CM, 2010, et al posterior circumflex humeral artery has a role in perusing humeral head [10]. Thus there exists diverse opinion about source of vascularity of humeral head.

The lower end on the other hand, showed an average number (mean) of 2.04 indicating good deal of vascularity of lower end. Vascular foramina of all size (majority being small sized) are found in lower end, maximum is found over lateral epicondyle. On observing the lower end, olecranon fossa showed constant number of vascular foramina which suggested that they are the gateway for the arteries which form the horizontal anastomoses [9]. The rich vascularity of distal third derived from horizontal anastomosis ensures sufficient vascularization of fragments after fracture [11]. Surgical interventions should be done with appropriate approach to preserve these vascular networks so as to aid early healing.

Zhiyun Yang and others (1998)[12] conducted a study to find whether there is any anatomical basis of developing avascular necrosis, which is infrequent in elbow trauma. The study stated that lower end is least susceptible to avascular necrosis because of rich anastomosis found at this region.

The shaft only showed few number of vascular foramina, among those the most important one, the nutrient foramina was observed.

The number of nutrient foramina was depicted. Majority of the humeri (148) showed one nutrient foramen while 48 showed two foramina and only 4 showed three foramina. Mysorekar (1967) [2], Forriol Campos (1987)[13] also shares a common view on this observation, as they stated that, the diaphyseal nutrient foramina in humerus is often two in number. Mysorekar (1967) et al, in bones having double foramina, the reciprocity of size is only observed in humerus. If foramen in the anteromedial surface is large, then that in spiral groove was smaller or vice versa. In other words, one would be main nutrient foramen while the other is accessory one. Bone without nutrient foramen was not found, this observation fail to support Longia G S (1980) [14]. This could be due to regional, genetic or any other variations in bones which are being studied upon.

The size of nutrient foramina was noted to be large in most case of over 91 %. This suggests the critical role of nutrient artery in vascularizing the bone. It is, therefore, in agreement with Trias and Ferry (1979)[15]. They stated that, the cortices of long bone depend on periosteal and medullary circulatory system. Medullary circulation being derived from nutrient artery is thus important as it supplies inner 2/3 rd of the cortex.

Direction of vascular foramina was observed to be straight in most cases (54%). Direction of vascular foramina over different segments were also observed, which turned out to be inconsistent.

Direction of nutrient foramina on observation didn't show any variation. All the nutrient foramina was directed toward the elbow which in accordance with general rule of direction of nutrient foramina

CONCLUSION

Humerus enjoys highest vascularity among upper limb bones as indicated by the higher density of vascular foramina. Among the segments, upper end shows maximum density of vascular foramina indicating the highest intensity of blood supply.

The shaft being, supplied mainly by nutrient artery, the location and direction of nutrient foramina was thus important to find out. The position of nutrient foramina in most cases is found to be in the middle 1/3rd of the anteromedial surface of the shaft and the direction of nutrient foramina was towards the elbow. Middle 1/3rd of anteromedial surface is more vulnerable to surgical or traumatic injuries that may damage nutrient artery, thus highlights its significance.

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Conflicts of Interests: None

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