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Original Research Article

DIAPHYSEAL NUTRIENT FORAMINA IN HUMAN ADULT HUMERUS

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ABSTRACT

Background: The humerus is bone of the arm. It is a long bone. Having knowledge on the location of the nutrient foramen can prevent a damage to the nutrient artery and can minimize the formation of a delayed union or a non-union of the fracture. The study was aimed at analyzing the nutrient foramen in dry adult humerii with reference to its number and location.

Materials and Methods: The study was conducted on 50 dry adult humerii preserved in the Department of Anatomy, JNIMS, Imphal. The bones were of unknown sex. The length of the bone, foraminal index, number of nutrient foramen, direction of the nutrient foramen and location of nutrient foramen were noted.

Results: The frequency of humerus with single nutrient foramen was highest (84%) while 16% of humerii had two nutrient foramen. In horizontal location of nutrient foramen, 48% of humerii had nutrient foramen in anteromedial surface, 40% at the medial border. In vertical location of nutrient foramen of humerii, 94% of nutrient foramen were located in zone II and 6% in zone III.

Conclusion: Knowledge on nutrient foramen of humerus will help surgeons in avoiding a limited area of the cortex of the long bone containing the nutrient foramen during an open reduction. The present study refutes the general notation that nutrient foramen of humerus is in its anteromedial surface as less than 50% is present on this surface.

KEY WORDS: Humerus, Nutrient Foramen, Delayed Union, Fracture, Non Union.

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INTRODUCTION

The humerus is bone of the arm. It is a long bone. It connects the scapula and the two bones of the forearm, the radius and ulna. The blood supply to the bones varies according to the shape of the bone. The diaphyseal nutrient artery is the main source of blood to long bones. The nutrient foramen is the largest of the foramen present on the shaft of long bone allowing nutrient artery to enter the bone, the role of which is important in providing nutrition and growth of long bones. It is an opening into the bone

shaft which gives passage to the blood vessels of the medullary cavity of a bone for its nourishment and growth[1]. Direction of the nutrient foramina is determined by the growing end of the bone. The position of nutrient foramen is constant during the growth of long bone[2]. The nutrient foramen of humerus is located at the anteromedial surface, a little below its midpoint, close to the medial border [3].

The bone is a very vascular structure. 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[4]. Absence of NF and hence the nutrient artery can deplete the blood supply to the ossifying bones and can result in ischemia of metaphysis and growth plate[5].

Having knowledge on the location of the nutrient foramen can prevent a damage to the nutrient artery and can minimize the formation of a delayed union or a non-union of the fracture[6]. An understanding of the location and the number of the nutrient foramina in long bones is important in orthopaedic surgical procedures such as joint replacement therapy, fracture repair bone grafts and vascularized bone microsurgery as well as medico legal cases[7]. Study of relative relationship between the length of bone and distance of nutrient foramen from either ends is useful in calculating the length of a long bone from a given fragment, which is important in medico-legal and anthropological work. From the length of the long bones height of an individual can be reconstructed [8]

Objectives: The study was aimed at analyzing the nutrient foramen in dry adult humerii with reference to its number and location. The location of the nutrient foramen was analyzed with respect to the surfaces and zones.

MATERIALS AND METHODS

The study was conducted on 50 dry adult humerii preserved in the Department of Anatomy, JNIMS, Imphal. The bones were of unknown sex.

The following parameters were observed:

The length of the bone was measured using osteometric board

Foraminal index (FI)

$$FI = D/L \times 100$$

where D is the distance of centre of NF from proximal end of bone L is the length of the bone Based on FI they were classified into one of the three types. Foraminal index below 33.33 indicates that nutrient foramen(NF) is in the proximal third of the bone, and the bone is grouped as type I; FI between 33.34 and 66.66 indicates NF in middle- third and is grouped as type II. FI more than 66.67 indicates that NF is in the distal third of the bone which is grouped as type III.

Number of Nutrient foramen: In bones having more than one foramen, the large sized foramen was recorded as the dominant foramen.

Direction and obliquity of the nutrient foramen was noted.

Location of Nutrient foramen: It was described into horizontal and vertical zones. Horizontal zone was with respect to the surface and border. Any foramen lying within 1mm from any border was taken to be lying on that border[9]. Vertical zone was with respect to the length of the bone determined by foraminal index.

Table 1: No. of nutrient foramina in each humerus.

No. of nutrient foramen	No. of bones	Percentage
1	42	84%
2	8	16%
3	0	0%

Table 2: Vertical location of nutrient foramen of humerus

Vertical location of nutrient foramen	No. of bones	Percentage
Zone I	0	0%
Zone II	47	94%
Zone III	3	6%

Table 3: Horizontal location of nutrient foramen of humerus.

No.	Horizontal location of nutrient foramen	No. of bones	Percentage
1	Anterior border	0	0%
2	Medial border	19	38%
3	Posterior border	0	0%
4	Anteromedial surface	24	48%
5	Anterolateral surface	3	6%
6	Posterior surface	3	6%

Fig. 1: Nutrient foramen of humerus in anteromedial surface.

Fig. 2: Nutrient foramen in posterior surface of humerus.

Fig. 3: Nutrient foramen in anterolateral surface of humerus (as indicated by the arrow).

Fig. 4: Nutrient foramen in medial border of shaft of humerus (arrow).

Fig. 5: Two nutrient foramina in shaft of humerus (circles).

DISCUSSION

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 bones following fractures and bone transplants [10]. One of the causes of delayed union or non-union in fracture is loss of blood supply and this emphasizes the major role of medullary arterial system in supplying blood to uniting callus and in revascularizing necrotic cortex of fracture site[11].

Chatrapati and Mishra found the total length of Humerus as 31.4cm[11] .Another study found the total length of humerus as 30.43cm[7]. The present study shows the main length of humerus as 29.5 cm which is shorter in comparison to the above studies.

In the present study, humerii with single nutrient foramen were most common (84%). In another study, only 50% of humerii had single foramen[4].In the present study, none of the humerii had more than two foramina while two studies have observed humerii with even upto 4 nutrient foramen [9,13].

In another study 3% of humerii had no nutrient foramen. They commented that even though long bones are supplied by epiphyseal arteries apart from nutrient arteries, it is not clear whether the epiphyseal arteries can nourish them during growth or it may be possible that nutrient vessels have altered course in bones with absent nutrient foramen[4].

In the present study, all the nutrient foramina in the humerus were directed distally. Longia GS *et al.* observed that the position of nutrient foramina was on the flexor aspect in their human

long bone specimens [8]. In another study, the location of the nutrient foramen in the anteromedial surface was 89.92%, that in the posterior surface was 8.53% and that in the anterolateral surface was 1.55%[14]. However, another study showed a highest percentage of location of nutrient foramen of humerus in medial border (57%) with only 43% on the anteromedial surface[15]. According to the present study, 48% of humerii had nutrient foramen in anteromedial surface, 40% at the medial border, 6% each in the anterolateral and posterior surface. The present study refutes the general concept that nutrient foramen of humerus is in its anteromedial surface as less than 50% is present on this surface.

According to a study, there is no correlation between the length of the humerus and the number of nutrient foramina[16]. The present study also showed similar report.

If surgeons could avoid a limited area of the cortex of the long bone containing the nutrient foramen, particularly during an open reduction, an improvement in the management of this problem might be attained[5].

CONCLUSION

The study concluded that nutrient foramina of the humerii were located mainly on the anteromedial surfaces and middle-third of the shaft. Only 48% of humerus had nutrient foramen on the anteromedial surface. The present study refutes the general notation that nutrient foramen of humerus is in its anteromedial surface as less than 50% is present on this surface. The majority of the humerii had a single nutrient foramen while only 16% had two nutrient foramen.

Conflicts of Interests: None

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