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MORPHOLOGICAL STUDY OF NUTRIENT FORAMEN OF ADULT HUMERUS AND ITS CLINICAL SIGNIFICANCE

Anatomy

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ABSTRACT

Background: Nutrient artery is the chief artery to supply the shaft of long bones. It enters the bone through the nutrient foramen. Lack of proper blood supply can cause delayed union or prevent the fracture healing. **Aim:** To study the number, location, position and direction of the nutrient foramen in adult humerii. **Materials & Methods:** 40 dried adult humerii were collected, observed the nutrient foramina, measured the required parameters and studied their clinical significance. **Results:** In the present study, 34(85%) bones had single nutrient foramen, 5(12.5%) bones had two nutrient foramina and only one(2.5%) bone had three nutrient foramina. 33(70.2%) nutrient foramina were present on the antero-medial surface of humerus, 5(10.6%) were present on the posterior surface, 3(6.4%) were present on the antero-lateral surface, 4(8.5%) were present along the medial border and 2(4.3%) were present along the lateral border of the humerus. All the foramina were directed towards the lower end and mostly present in the middle 1/3rd of the bone. **Conclusion:** Majority of humerii are having one nutrient foramen on the antero-medial surface and in the middle 1/3rd of the bone. The knowledge of the morphology of the nutrient foramen and its artery is very useful for the Orthopaedic surgeons to do surgical procedures on the humerus.

KEYWORDS

Humerus, Nutrient foramen, Nutrient artery, Foraminal index

INTRODUCTION:

Bone is richly supplied with blood vessels which pass into it from the periosteum. Near the centre of a long bone, a canal passes obliquely through the compact bone. This canal is known as medullary or nutrient canal, and its opening on the surface of the bone is known as nutrient foramen [1]. The artery which passes through the nutrient foramen is known as nutrient artery. It is very important for the bones during their active growth period in embryonic and foetal life and also provides nourishment to them. All the long bones have one or two main diaphyseal nutrient arteries which enter the shaft obliquely through the nutrient foramina leading to nutrient canals without branching in the canal and accompanied by several thin walled veins and a myelinated nerve. These nutrient canals are directed away from the dominant growing epiphysis [2,3].

The nutrient artery grows in the periosteal bud and enters the middle of the shaft of the long bones. Before piercing the bone, it presents a tortuosity which minimises the blood pressure and allows movement of the bone without affecting the nutrient vessel. Within the bone the artery divides into two branches, one for each end known as nutritiae. Each branch subdivides into parallel branches which enter the metaphysis and form hair pin like loops. These loops anastomose with periosteal, juxta - epiphyseal and epiphyseal arteries. The nutrient artery supplies the bone marrow and inner 2/3^{rds} of the compact part of the diaphysis [4,5]. Brachial artery gives the main nutrient artery to the humerus. If two are present, the second one is from the profunda brachii artery.

Humerus is one of the commonest bone which is fractured at different sites like surgical neck, middle of the shaft, supracondylar part or the epicondyles. All these parts are related with important nerves and vessels. Improper immobilisation and excessive distraction at the fracture site leads to mal-union or delayed union of the fracture ends which require open reduction and sometimes bone grafting. Intake of some of the drugs like thalidomide during pregnancy, interferes with vascularisation and leads to death of the mesenchymal cells in the early limb bud causing phocomelia [6]. So the detailed knowledge of the number, location and the direction of the nutrient foramen of humerus is very important to the orthopaedic surgeons for proper diagnosis and treatment of the patients with fractures of humerus.

MATERIALS & METHODS:

The present study was done on 40 dried humeri collected from the Department of Anatomy, Guntur medical college, Guntur and Rangaraya medical college, Kakinada. All the collected Humerii were observed with the help of hand lens and ball pins to identify the direction of the nutrient foramen, measured the following parameters with the help of osteometric board, scale and studied their clinical significance in detail. Damaged and pathological bones were excluded from the study.

1. Total length of the humerus [TL]
2. Number of nutrient foramen
3. Location of the nutrient foramen in relation to the surfaces of humerus
4. Distance of nutrient foramen from the upper end of the humerus [DNF]
5. Calculation of Foraminal index [FI] by using the formula: FI = DNF/TL*100. The position of the nutrient foramen was divided into three types basing on the FI [7].

- Type 1: FI < 33.33, the foramen was present in proximal 1/3rd of the bone.
- Type 2: FI, 33.33 - 66.66, the foramen was present in the middle 1/3rd of the bone.
- Type 3: FI > 66.66, the foramen was present in distal 1/3rd of the bone.

RESULTS:

The present study was done on 40 dried adult humerii. We observed the average length of all humerii as 30.5cms that ranged from 24cms to 34cms. The average distance of nutrient foramen from the upper end of the humerus was 17.15cms which ranged from 10.5cms to 28cms. The average foraminal index [FI] of the nutrient foramen was 56.13 which was ranged from 38.2 to 85.88.

In the present study, 34(85%) bones had single nutrient foramen, 5(12.5%) bones had two nutrient foramina [figure 1] and only one(2.5%) bone had three nutrient foramina (table 1). 33(70.2%) nutrient foramina were present on the anteromedial surface, 5(10.6%) were present on the posterior surface [figure 2], 3(6.4%) were present on the anterolateral surface [figure 3], 4(8.5%) were present along the medial border [figure 1] and 2(4.3%) were present along the lateral border of the humerus (table 2).

Table 1: Showing the number of nutrient foramen on the humerii

Number of nutrient foramen	Number of humerus bones	Percentage(%)
1	34	85
2	5	12.5
3	1	2.5

Table 2: Showing location of nutrient foramen on the humerus

Surface/border of the humerus	Number of humerus bones	Percentage(%)

Anteromedial surface	33	70.2
Anterolateral surface	3	6.4
Posterior surface	5	10.6
Medial border	4	8.5
Lateral border	2	4.3

Most of the foramina, 96% were present on the middle 1/3rd of the bone and their foraminal index was between 33.33 - 66.66 and belongs to type 2. 4% foramina were present in the lower 1/3rd of the bone [figure 1]. Its foraminal index was more than 66.66 and belongs to type 3. We observed that all the nutrient foramina were directed towards lower end so upper end of the humerus was the growing end.

Figure 1: Showing two nutrient foramina on medial border & lower end of humerus

Figure 2: Showing nutrient foramen on the posterior surface of humerus

Figure 3: Showing nutrient foramen on the antero-lateral surface of humerus

DISCUSSION:

During ossification of bone from the cartilaginous model, the calcified cartilage in the mid-section of the model begins to break down. The osteogenic layer of periosteum forms the periosteal bud which contains osteoclasts, osteoblasts and blood vessels. The bud excavates passages through the newly formed bones and passes into the calcified matrix as the primary ossification centre. The perforation of the bud persists as nutrient canal [5].

Humerus is the bone of arm and has the highest vascularity among the bones of the upper limb. It is mainly supplied by branches from the brachial artery and also from the axillary, radial and ulnar arteries. Nutrient artery supplies bone marrow and inner 2/3rds of the compact part of the diaphysis. Arterial supply of adult humerus was studied by Laing [8], he stated that during the surgical procedures done on the shaft of humerus, nutrient artery should be protected.

In the present study on humerus bone, 85% of bones had one nutrient foramen, 12.5% bones had two nutrient foramina and 2.5% bones had three nutrient foramina. In the study done by Asharani S K, Ajay Ningaiah [9] on 120 humerii, they observed one nutrient foramen in 87% bones, two foramina in 11% bones and no dominant foramen in 2% bones. In our study all the humerii had nutrient foramina. According to the study done by Sabah Yaseen et al [10], three nutrient foramina were seen in 2% of humerii.

Bharathi A et al [11] reported in their study on humerii that majority of the nutrient foramina (94%) were present on the antero-medial surface, out of these 21% present on the medial border and 73% were present on the antero-medial surface. 2% foramina were present on the antero-lateral surface and 4% were present on the posterior surface. In the present study, 70.2% nutrient foramina were present on the antero-medial surface, 6.4% foramina were present on the antero-lateral surface, 10.6% foramina were present on the posterior surface, 8.5% foramina were present over the medial border and 4.3% foramina were present along the lateral border of humerus. Among all these, 94% foramina were located in the middle 1/3rd of the bone and 4% were present in the lower 1/3rd of the bone. Shishir Kumar and Shivarama Ch [12] observed in their study and reported that 86.36% of foramina were present in middle 1/3rd, 4.55% were present in the lower 1/3rd and 9.09% were present in the upper 1/3rd of the humerus. In our study, no humerus had nutrient foramen in the upper 1/3rd of the bone.

CONCLUSION:

Humerus is the important upper limb bone which is fractured frequently. It is supplied by nutrient artery and also by the periosteal, metaphyseal and epiphyseal arteries. Majority of humerii are having one nutrient foramen on the antero-medial surface and in the middle 1/3rd of the bone. The knowledge of the morphology of the nutrient foramen and its artery is very useful for the Orthopaedic surgeons to do surgical procedures on the humerus bone.

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