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Morphometric Variations of Nutrient Foramen in Adult Human Humerus in Telengana Region

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Abstract:
Background: *The nutrient foramina are cavities that conduct the nutrient arteries and the peripheral nerves on the shaft of long bones. Long bones receive most of the interosseous blood supply from the nutrient arteries, and sometimes through the periosteal vessels. It is not uncommon to see the non union of the fractures in the long bones. Among the various reasons for the nonunion of the fractured bones, the nutrient artery plays an important role.*
Objectives: *It was found that most of the long bones follow the dictum "Towards the elbow I go, away from the knee I flee". The Direction of nutrient foramen is opposite to growing end i.e . away from the elbow. This study was aimed at analyzing the nutrient foramina in dry adult humerii , with regards to the number, size and the location of the nutrient foramen with respect to the surfaces and the zones of the humerus.*
Materials: *This was an analytical study. All the humerii from department of anatomy, Osmania medical college in hyderabad were included in the study. The following parameters were noted; The length of the humerus, the number and the location of the nutrient foramen with respect to the surfaces and the zones of the humerus. The length of the humerus and the zones of the humerus were measured by using the osteometric board. When more than one foramen was found, the larger one was taken as the dominant foramen. All the data were noted.*
Results: *Totally, 100 adult dry humerii were studied. The mean length of the humerii was 28.46cm, with a SD of 2.18. In majority of the humerii (94%), the nutrient foramen was located in the middle 1/3rd of the bone and in 6% of the bones, it was located in the lower 1/3rd of the bone. The location of the nutrient foramen in the anteromedial surface was 92%, that in the posterior surface was 6% and that in the anterolateral surface was 2%.*
Conclusion: *This anatomical study of nutrient foramina in shaft of long bones is of paramount importance for orthopaedic surgeons doing open reduction of fractureof mid shaft humerus, in order to avoid injuy to nutrient artery & thereby reducing the chances of delayed or non-union of fracture shaft humerus and also important in surgical procedures like bone grafting and microsurgical bone transplantation.*
Keywords: *Humerus, Diaphysis, Nutrient foramen, Nutrient artery, Humerus fracture*

I. Introduction

The fractures of the long bones are increasing in number, due to an increase in the numbers of industrial and road traffic accidents, sports injuries and pathological fractures in osteoporotic victims. The non union of a fractured bone can be a complication of a closed or an open reduction.

When the blood supply is not established well, it can be complicated by a delayed union or a nonunion of the fracture and this reveals that the medullary arterial system plays an important role in the revascularization of the necrozing cortex and the uniting callus of the fracture site [1].

On this basis, having knowledge on the location of the nutrient foramen and the relevant anatomy, the surgeon can prevent a damage to the nutrient artery and can minimize the delayed union or a non union of the fracture [2]. Hence, this study was aimed at analyzing the nutrient foramen of the humerii.

II. Materials And Methods

This was an analytical study. All the humerii from the department of anatomy, Osmania Medical College in hyderabad were included in the study. The length of each humerus bone was measured from the superior aspect of the lesser tubercle to the inferior surface of the medial epicondyle of the humerus by using an osteometric board . Further, the humerus bone was divided into three equal zones, as zone I (upper 1/3rd), zone II (middle 1/3rd) and zone III (lower 1/3rd) with the help of the osteometric board. The following parameters were noted; The length of the humerus, The location of the nutrient foramen was noted with respect to the three surfaces, namely, the anteromedial, the anterolateral and the posterior and the three zones, namely, zone I, zone II and zone III. When more than one foramen was found, the larger one was taken as the dominant foramen. All

the data were noted. All the parameters were noted by using Vernier caliper , Osteometric board and magnifying glass.

Parameters:

1. Total length (L) of the bone; Further, the humerus bone was divided into three equal zones, as zone I (upper $1/3^{rd}$), zone II (middle $1/3^{rd)}$ and zone III (lower $1/3^{rd}$).
2. The number of the nutrient foramen.
3. The location of the nutrient foramen with respect to the surfaces and zones were analysed.

III. Results

Totally, 100 adult dry humerii were studied, of which 56% were left sided bones and 44% were right sided bones. The mean length of the humerii was 28.46 cm, with a SD of 2.18, which ranged from 25 to 31 cms. The location of the nutrient foramen in the anteromedial surface was 94%, that in the posterior surface was 4% and that in the anterolateral surface was 2%.

Though some humerii had two or more nutrient foramina, a majority of the humerii had a single nutrient foramen. Most of the humerii have single nutrient foramina (94%), only 6%of humerii show double nutrient foramina, surprisingly all additional nutrient foramina are present on posterior surface only.

Number of nutrient foramen in humerii (n=100)

Number Of Foramina	Number Of Humeri	Percentage
1	94	94%
2	6	6%

A majority of the nutrient foramina were located in the anteromedial surfaces of the humerii (94%), out of these 21% present on medial border, rest of 73% were present on the anteromedial surface. 2% were present on anterolateral surface, 4% were present on posterior surface. 6% of humerii showed additional foramina surprisingly all were present on posterior surface only.

Location of number of nutrient foramen with regard to surfaces of humerus (n-100)

Location Of Nutrient Foramen	Number Of Humerii	Percentage
Anteromedial Surface Of Humerus	94	94%
Anterolateral Surface Of Humerus	2	2%
Posterior Surface Of Humerus	4	4%

Similarly, a majority of the humerii had the nutrient foramina in zone II (middle 1/3) of the bone(92%). In 8% of the bones, it was located in the zone III (lower $1/3^{rd}$). In only one bone we found additional foramina in zone I(upper $1/3^{rd}$) along with nutrient foramina in middle $1/3^{rd}$ of the bone.

Location of number of nutrient foramen with regard to zones of humerus (n-100)

Number Of Foramen	Number Of Humerii	Percentage
Zone-I	Nil	-
Zone-Ii	92	92%
Zone-Iii	8	8%

IV. Discussion

The blood supply is the main factor in the healing of fractures[3-5] . Any damage to the nutrient artery during surgical fixations or subsequent manipulations, is a significant factor which predisposes to delayed unions or nonunions[6-10] . 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. Laing studied the vascularity of the humerus and he concluded that the main nutrient artery of the humerus must be protected from injuries during operations which are done on the humeral shaft [6]. Carroll stated that the nutrient artery enters through the restricted anteromedial surface, in the middle $1/3^{rd}$ of the humerus and that the surgeries which are done on the middle $1/3^{rd}$ of the shaft of the humerus should be handled well without causing damage to the nutrient artery, in order to prevent delayed unions or non unions of the fractures. Our study results correlated well with those of Carroll's study. Many studies which have been done on the humerus bone have revealed that a majority of the humerii had one nutrient artery and that some had additional accessory arteries. This could be because of the variation in the population. There is no correlation between the length of the humerus and the number of the nutrient foramina according to the studies which were done by Manjunath S Halagatti and Chhatrapati DN [11,12]. Hence, we did not attempt to correlate the same. This study adds a message to the existing knowledge, that a variation in the population can result in a variation in the number of nutrient foramina and their location.

In embryonic period all the nutrient arteries course caudally.This is true in hemodynamic point of view to force the blood from cephalic to caudal side. This agrees with adult rules "towards the knee and away from elbow". This is said to be due to unequal growth of the ends of the long bones. The arrangement of diaphyseal nutrient foramen in long bones usually follows a definite pattern. Position is constant and seen on flexor surfaces. (Shamsunder Rao, 2014)[13]. The direction of nutrient foramina in human long bones is directed away from the growing end. This is due to one end of long bone is growing faster than the other end. In many tetra pods**,** there is variation in the directions of nutrient foramina, but in mammals and birds Hughes pointed out that Anomalous canal are frequent (Hughes, 1952)[14]. The blood supply of femur and humerus has been investigated by Lutken (Lutken Poul, 1950)[15], Laing (Laing,1953) and Carroll (Carroll, 1963).

Location of nutrient foramen in different segments of long bones:

Mysorkar reported the nutrient foramen in Humerus along the medial border in 4th segment. The present study correlates with this study. A majority of the nutrient foramina were located in the anteromedial surfaces of the humerii (94%), out of these 21% present on medial border, rest of 73% on the anteromedial surface. 2% present on anterolateral surface, 4% present on posterior surface. 6% of humerii showed additional foramina surprisingly all are present on posterior surface only.

Direction of nutrient canal & Percentage of nutrient foramen in long bones:

Direction and obliquity of nutrient canal shows the general pattern i.e away from the elbow.
The direction of nutrient foramina in human long bones is directed away from the growing end. This is due to one end of long bone is growing faster than the other end (Mysorekar,
1967)[16]. In the present study also our findings correlate with this author. Though some humerii had two or more nutrient foramina, a majority of the humerii had a single nutrient foramen. Most of the humerii have single nutrient foramina (94%), only 6%of humerii show double nutrient foramina, surprisingly all additional nutrient foramina are present on posterior surface only.

V. Conclusion

This study concludes that the nutrient foramina of the humerii were not only located on the anteromedial surfaces but also on the anterolateral and the posterior surfaces also. Similarly, the nutrient foramen of the humerus were found on both the middle and the lower third of the shaft. A majority of the humerii had a single nutrient foramen, though some humerii had more than one nutrient foramen.
This anatomical study of nutrient foramina in shaft of long bones is of paramount importance in medico-legal aspect and also important in surgical procedures like bone grafting and micro -surgical bone transplantation.

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Fig -1 showing double nutrient foramina

Fig -2 showing nutrient foramina in the Zone-III (lower zone)

Fig -3 showing nutrient foramina on posterior aspect

Fig -4 showing double nutrient foraminae- one on antero-medial surface another on the posterior surface

Fig-5 showing nutrient formania on the medial border