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Original Research Article

Nutrient foramen of humerus

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ABSTRACT

Background: Humerus is a typical long bone of arm in human body extending from shoulders to elbow. Nutrient foramen is the small opening present in most of the bone of human body to transmit the nutrient artery which supplies nutrition to different parts of bone. The aim of the present study is to identify the number of nutrient foramen in dry humerus and to observe direction and allocation of the nutrient foramina.
Methods: The present study was carried out in 60 dry humeri (23 rights and 37 lefts) collected from Department of Anatomy, Government Medical College Srinagar. Bones were examined with respect to the number, direction and anatomical location of nutrient foramen.
Results: Out of 60 dry humeri, 36 (60%) had a single nutrient foramen, 14 (23.3%) had double, 7 (11.6%) had triple and 3 (5%) had no nutrient foramen. About 52% of the bones had nutrient foramen on the medial border, 40% on the Anteromedial surface, 3% on lateral border, 3% on posterior surface and 2% on the anterior border. Majority of the bones i.e., 81% have the nutrient foramen in the middle 1/3rd zone, 17% at the junction between middle 1/3rd zone and lower 1/3rd zone and 2% in the lower 1/3rd zone.
Conclusions: By knowing the number and location of the nutrient foramina in humerus it is useful in preventing intra-operative injury of nutrient artery during orthopedic, plastic and reconstructive surgery.

Keywords: Nutrient foramen, Humerus, Coracoclavicular, Sternoclavicular ligaments

INTRODUCTION

Bone is a highly vascular mineralized connective tissue which performs numerous vital functions in the human body. The blood supply to the bones varies according to the shape of the bone. In long bones, there are generally three sets of vessels: The diaphyseal, metaphyseal and epiphyseal arteries. The diaphyseal nutrient artery is the main source of blood to long bones, especially during its active growth period and the early stages of ossification. With their accompanying veins, these arteries usually penetrate the cortex obliquely through the nutrient foramen (NF) which leads into nutrient canals.[1] Humerus is a typical long bone of arm in human body extends from shoulder to elbow. It is very important bone of upper limb with attachment of major muscles like biceps, triceps and deltoid etc. which transmits weight from hand, forearm to the axial skeleton through clavicle by the help of coracoclavicular, sternoclavicular ligaments. Nutrient foramen is the small opening present in most of the bone of human body to transmit the nutrient artery which supply nutrition to different part of bone.[2-4]

Absence of nutrient foramen and hence the nutrient artery can deplete the blood supply to the ossifying bones and can result in ischemia of metaphysic and growth plate.[5,6] Apart from this, injury to the nutrient artery at the time of fracture, or during subsequent manipulation and surgery may be a significant predisposing factor to faulty union of long bones.[7] Non-union of the humeral shaft remains a

difficult clinical problem as the healing of fractures is dependent upon blood supply.[8,9]

The fractures of long bones are increasing in number due to an increase in road traffic accidents, industrial accidents, sports injuries and pathological fractures in osteoporotic patients. Nonunion of a fractured long bone can be a complication of closed or an open reduction.[10] Nonunion of a fracture of long bone is a state in which all healing processes have come to a halt as diagnosed by clinical and radiological evidence beyond the stipulated time due to various reasons usually requiring a change in the treatment. One of the very important reasons for nonunion is loss of blood supply to the fractured bone. Damage to nutrient vessels, excessive stripping or injury to periosteum and muscle are few causes for loss of blood supply to the fracture site.[11] The study aimed to find out the numbers of nutrient foramen in dry humerus. The study showed the direction of foramina and their allocation according to foraminal index in Humerus. This type of study will aid in forensic department to identify the bone, surgery department for bone graft, medical student to understand the nutrient foramen of humerus with its direction and foraminal index.

Aim and objectives

Aim and objective of current study was to identify the number of nutrient foramen in dry humerus and to observe direction and allocation of the nutrient foramina.

METHODS

After obtaining the ethical clearance from the Institutional Ethical Committee, the present prospective observational study was carried out in the department of anatomy, Government medical college Srinagar from February 2022 to April 2022 on 60 dry humeri (23 rights and 37 lefts). Damaged bones and bones with healed fractures were excluded from this study. The distances from proximal end of Humerus to the nutrient foramen and the total length of humerus were measured by using vernier caliper in mm. The nutrient foramen was observed in all surfaces; anteromedial, anterolateral and posterior surfaces and borders; medial, lateral and posterior of humeral diaphysis and noted in paper as it present either single, double or triple or more. Then the direction of nutrient foramen was confirmed by inserting probe (as needle) inside the foramen. According to foraminal index position of nutrient foramen in bone were classified into Zone I, Zone II, and Zone III. Zone I was defined as foramina index below 33.33, Zone II is defined as foraminal index from 33.33 to 66.66, similarly, zone III is defined as the foraminal index above 66.66. The recorded data was compiled and entered into a spreadsheet (Microsoft Excel) and then exported to the data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Categorical variables were summarized as frequencies and percentages. Graphically, the data was presented by bar diagrams.

RESULTS

Out of 60 dry humeri, 36 (60%) had a single nutrient foramen, 14 (23.3%) had double, 7 (11.6%) had triple and 3 (5%) had no nutrient foramen.

Table 1: Distribution according to bone characteristics.

Characteristics		Number of Bones	%
Type of foramen	Single nutrient foramen	36	60
	Double nutrient foramen	14	23.3
	Triple nutrient foramen	7	11.6
	No nutrient foramen	3	5.0
Side of foramen	Medial border	31	51.66
	Left	29	49.33
Site of foramen	Medial border	31	51.66
	Anteromedial surface	24	40.0
	Lateral border	2	3.33
	Posterior surface	2	3.33
	Anterior border	1	1.66
Zone	Middle 1/3rd zone	49	81.66
	Between middle 1/3rd zone and lower 1/3rd zone	10	16.66
	Lower 1/3rd zone	1	1.66

About 52% of the bones had nutrient foramen on the medial border, 40% had nutrient foramen on the Anteromedial surface, 3% on lateral border, 3% on posterior surface and 2% had nutrient foramen on anterior border. Majority of the bones i.e., 81% have the nutrient foramen in the middle 1/3rd zone, 17% at the junction between middle 1/3rd zone and lower 1/3rd zone and 2% in the lower 1/3rd zone. All the nutrient foramina were directed towards the elbow joint i.e., away from the growing end.

DISCUSSION

In the present study, out of 60 dry humeri, 36 (60%) had a single nutrient foramen, 14 (23.3%) had double, 7 (11.6%) had triple and 3 (5%) had no nutrient foramen. 51.66% of the bones had nutrient foramen on the medial border, 40% had nutrient foramen on the Anteromedial surface, 3.33% on lateral border, 3.33% on posterior surface and 1.66% had nutrient foramen on anterior border. Majority of the bones i.e., 81.66% have the nutrient foramen in the middle 1/3rd zone, 16.66% at the junction between middle 1/3rd zone and lower 1/3rd zone and 1.66% in the lower 1/3rd zone. All the nutrient foramina were directed towards the elbow joint i.e., away from the growing end.

In a study conducted by Bhojaraja et al humeri with single nutrient foramen were most common (77%) followed by two (18%) and three NF (2%) which is similar to earlier reports.[12-14] A study done by Khan et al on 75 humerus, 90% of humerii had single nutrient foramen. Among them, 96% were located on the middle 1/3rd of anteromedial surface, 2.67% on the posterior surface and 1.33% on the anterolateral surface.[15] Ukoha et al studied 150 humerii and found that 66% of them had a single foramen, 18% had double foramina and 26% had no foramen. In their study all foramina except one were directed away from the growing end.[16] Roul et al in their study observed that nutrient foramen was found in middle 1/3rd in most of the cases and in lower 1/3rd in few cases.[17] This finding was supported by another study done by Chandrasekaran and Shanthi. The result of the present study also correlates with this. In addition to that the percentage of location of nutrient foramen on the anteromedial surface was 89.92%, on the posterior surface was 8.53% and on the anterolateral surface was 1.55%. According to the study of Yaseen et al on 100 dry humerii, 79% had 1 foramen, 19% had 2 foramina and only 2% had 3 foramina.[18] In their study 88.5% of foramina were present on the anteromedial surface, 3.5% on anterolateral surface and 11% on the posterior surface. With respect to the zones 89% were located in Zone II and 11% in Zone III. None of them were located in Zone I.[19] In a study of 200 humerii by Joshi et al 63% had a single nutrient foramen which implies that the major blood supply to humeral shaft will enter at one particular point.[20]

In another study by Asharani et al 87% bones have one nutrient foramen and 11% have two foramina. Majority of the bones have nutrient foramen located mainly on the medial border (57%), then on the anteromedial surface (43%), lateral border (3%), posterior surface (3%) and anterior border (2%).[20] 87% have the nutrient foramen located in the Zone II, 22% in the junction between Zone II and Zone III and 2% in the Zone III.[21]

Limitations

Limitations of current study were the small sample size and single centered study.

CONCLUSION

Orthopaedic surgical procedures like vascularized bone microsurgery requires the detailed knowledge about the blood supply of the operating bone. Surgeons should be mindful of soft tissue in the foraminal area during surgical procedures. By knowing the number and location of the nutrient foramina in humerus is useful in preventing intra-operative injury of nutrient artery during orthopedic, plastic and reconstructive surgery.

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