



Research Article

MORPHOMETRIC STUDY OF NUTRIENT FORAMINA OF HUMERUS IN RAYALASEEMA REGION OF ANDHRA PRADESH

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ABSTRACT

Background: Nutrient foramen is an opening in the middle of shaft of humerus which gives passage to blood vessels of medullary cavity of a bone for its nourishment and growth. The knowledge of location of nutrient foramen is important in surgical procedures like bone grafting and recently in microsurgical vascularized bone transplantation.

Objective: To study the number, size, direction and location of foramina with respect to the surfaces and zones.

Materials and methods: Present study was done on 100 dried, adult, normal humerus bones (50 – right, 50 – left) obtained from the Department of Anatomy, Kurnool Medical College, Kurnool.

Results: It was observed that 82% of humeri had a single nutrient foramen and 18% had double foramina and in no bone the nutrient foramen was absent. It was also observed that the size of foramen was ≥ 0.55 to < 0.71 mm in 96.6% and ≥ 0.71 to < 1.1 mm in 3.39%. Majority (83.05%) of nutrient foramina were present on anteromedial surface, 11.86% on anterolateral surface and 5.08% on posterior surface.

Conclusion: Knowledge of number, size, direction and location of nutrient foramina in humerus would be useful in preventing intraoperative injury of nutrient artery during orthopaedic, plastic and reconstructive surgeries.

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INTRODUCTION

Humerus is the longest and largest bone of the upper limb. One or two main diaphyseal nutrient arteries enter the shaft obliquely through nutrient foramina which lead into nutrient canals. Their sites of entry and angulation are almost constant and characteristically directed away from dominant growing epiphysis. Nutrient arteries do not branch in their canals but divide into ascending and descending branches in the medullary cavity which approach the epiphysis, dividing repeatedly into smaller helical branches close to the endosteal surface. The endosteal vessels are vulnerable during operations which involve passing metal implants into the medullary canal, eg. Intramedullary nailing for fractures^[1]. The nutrient artery enters the shaft antromedially about the middle of the bone if derived from brachial artery and posteriorly if derived from profunda brachii. The nutrient artery supplies most of the marrow and cortex^[2]. The directions of nutrient foramina of long bones follow the rule of “To the elbow I go, from the knee I flee”. Therefore, in the upper extremity, shoulder and wrist ends of the bones are the growing ends. In the lower extremity, knee ends of femur, tibia and fibula are the growing ends^[3].

The topographical knowledge of these nutrient foramina is useful in operative procedures to preserve circulation^[4]. Nutrient artery is the major source of blood supply to bone and it plays an important role in healing of fracture. Orthopaedic surgical procedures like vascularized bone microsurgery requires the detailed knowledge of the blood supply. In vascular bone grafting, the blood supply by nutrient artery is extremely important and must be preserved in order to promote fracture healing^[5]. Study of nutrient foramina in upper limb is very important for morphological, clinical and pathological point of view. The knowledge of blood supply to long bones is crucial in the development of new transplantation and resection techniques in orthopaedics^[6].

MATERIALS AND METHODS

The present study was done on 100 dried, adult, normal humerus bones (50 belong to right and 50 belong to left) obtained from the Department of Anatomy, Kurnool Medical College, Kurnool. The bones were observed for the number, size, direction and location of nutrient foramina with respect to the surfaces and zones. The size of foramina was measured by using 18, 22, 23 and 24 gauge needles. The foramina which admitted 18G needle were considered to be greater than 1.1mm, the foramina which admitted 22G needle were considered to be 0.71mm, the foramina which admitted 23G needle were considered to be 0.6mm and the foramina which admitted 24G needle were considered to be 0.55mm. Bones

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were divided into 3 zones: zone 1 – junction of upper 1/3rd and middle 1/3rd, zone 2 – middle 1/3rd and zone 3 – lower 1/3rd of the shaft.

RESULTS

It was observed that majority of humeri had a single nutrient foramen and few had double foramina and in no bone the nutrient foramen was absent (Table 1) (Fig 1). It was also observed that the size of foramen was ≥ 0.55 to < 0.71 mm in 96.6% and ≥ 0.71 to < 1.1 mm in 3.39% (Table 2). Majority of nutrient foramina were present on anteromedial surface followed by anterolateral and posterior surfaces (Table 3) (Fig 2). Majority of bones (94.92%) have the nutrient foramen in the middle 1/3rd, 2.54% at the junction between upper 1/3rd and middle 1/3rd and 2.54% in the lower 1.3rd (Table 4). All the foramina were directed towards the lower end of humeri i.e. away from the growing end.

Table 1 Number of nutrient foramina

| No. of nutrient foramina | Right | | Left | | Total percentage |
|--------------------------|--------|------------|--------|------------|------------------|
| | Number | Percentage | Number | Percentage | |
| 0 | 0 | 0% | 0 | 0% | 0% |
| 1 | 40 | 80% | 42 | 84% | 82% |
| 2 | 10 | 20% | 8 | 16% | 18% |

Table 2 Size of nutrient foramina

| Size of nutrient foramina | Right | | Left | | Total percentage |
|----------------------------|--------|------------|--------|------------|------------------|
| | Number | Percentage | Number | Percentage | |
| ≥ 0.55 to < 0.71 mm | 60 | 50.85% | 54 | 45.76% | 96.61% |
| ≥ 0.71 to < 1.1 mm | 0 | 0% | 4 | 3.39% | 3.39% |
| ≥ 1.1 mm | 0 | 0% | 0 | 0% | 0% |

Table 3 Location of nutrient foramina in different surfaces of shaft

| Location of nutrient foramina | Right | | Left | | Total percentage |
|-------------------------------|--------|------------|--------|------------|------------------|
| | Number | Percentage | Number | Percentage | |
| Anteromedial | 52 | 44.07% | 46 | 38.98% | 83.05% |
| Anterolateral | 6 | 5.08% | 8 | 6.78% | 11.86% |
| Posterior | 2 | 1.69% | 4 | 3.39% | 5.08% |

Table 4 Location of nutrient foramina in different zones of shaft

| Zones | No. of nutrient foramina | Percentage |
|--------|--------------------------|------------|
| Zone 1 | 3 | 2.54% |
| Zone 2 | 112 | 94.92% |
| Zone 3 | 3 | 2.54% |



Single nutrient foramen



Double nutrient foramina

Fig 1 Number of nutrient foramina



Anteromedial and anterolateral



Posterior

Fig 2 Location of nutrient foramina

DISCUSSION

The knowledge of variations of nutrient foramina is significantly important for orthopaedic surgeons undertaking an open reduction of a fracture to avoid injury to nutrient artery and thus lessening the chances of delayed or non-union of the fracture [7].

The present study showed that single nutrient foramen was present in 82% of humeri which is approximately similar to that of Pankaj *et al* (2017) [8] and Manjunadh *et al* (2011) [9]. But the study conducted by Khan A S *et al* (2014) [10] showed that 90% of humeri with single nutrient foramen and Ukoha UU *et al* (2013) [11] showed that 66% of humeri with single nutrient foramen, which differs from the present study. The incidence of double foramina was 18% in the present study which correlates with study of Ukoha UU *et al* (18%) and also with that of Manjunath *et al* (17.5%).

In the present study, the size of nutrient foramen ranged from ≥ 0.55 to < 0.71 mm in majority of humeri (96.61%) and ≥ 0.71 to < 1.1 mm in 3.39% of humeri whereas in the study conducted by Pankaj *et al* it is < 1 mm in 21.84%, 1 to 2 mm in 74.21% and > 2 mm in 3.95% of humeri.

In the present study, most of the foramina were found on anteromedial surface (83.05%) followed by anterolateral (11.86%) and posterior surfaces (5.08%) whereas the study of Santhosh Manohar Bhosale *et al* (2016) [12] showed 83.33% on anteromedial surface followed by 15.15% on posterior surface and 1.5% on anterolateral surface. The study of Ankana Saha *et al* (2017) [13] showed 76.85% on anteromedial surface followed by anterolateral and posterior surfaces. Bhavana Khande *et al* (2018) [14] and Pankaj *et al* observed that most of the humeri with nutrient foramen in the middle 1/3rd and few humeri with nutrient foramen in the lower 1/3rd. This study was also supported by a study done by Chandrasekharan S *et al* (2013) [15]. The result of present study also correlates with this.

The present study observed that the direction of all the nutrient foramina of humeri was towards the lower end of humerus which was supported by many studies.

CONCLUSION

Majority of humerus bones have single nutrient foramen, located mainly on the anteromedial surface especially in the middle 1/3rd. The direction of all the foramina was towards the lower end of humerus i.e. away from the growing end. The knowledge of number, size, location and direction of nutrient foramina of humerus is very important for orthopaedic surgeons during surgical procedures like bone repair, bone grafting and microvascular bone surgery.

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