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A STUDY ON NUTRIENT FORAMEN OF RADIUS AND ITS CLINICAL SIGNIFICANCE

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Abstract
Background: The radius is the lateral bone of the forearm and lies parallel to the ulna. It consists of an upper end, a lower end, and an intervening shaft. The nutrient artery that supplies the radius is the anterior or posterior interosseous artery, entering through the nutrient foramen, which leads to the nutrient canal. The location of this foramen is crucial during fracture healing or bone grafting, as both processes rely on adequate blood supply. Therefore, this study aims to determine the position of the nutrient foramen and its clinical implications. **Materials and Methods:** Fifty dry human radii were collected from the Department of Anatomy at Rajah Muthiah Medical College, Chidambaram, and Government Erode Medical College, Perundurai, for this study. The number, position, and direction of the foramen were observed in each bone. **Result:** Among the fifty radii examined, a single foramen was observed in the middle one-third of the anterior surface of the radius in forty-six bones, in two bones it was seen on the posterior surface, and in another one, it was seen on the lateral surface. One radius was found without a visible nutrient foramen. The nutrient foramen was consistently directed upwards in all the radii examined. **Conclusion:** Understanding the location of the nutrient foramen in the radius will provide clinicians with valuable information for internal fixation and bone grafting procedures.

INTRODUCTION

Radius is the lateral and preaxial bone of the forearm, corresponding to the tibia of the lower limb. It consists of upper and lower ends and an intervening shaft. The proximal end of the radius includes a head, neck, and a radial tuberosity. The shaft has a triangular cross-section in the middle third and exhibits three borders: anterior, posterior, and interosseous, as well as three surfaces: anterior, posterior, and lateral. The nutrient foramen, which points towards the elbow, is situated on the anterior surface near the middle of the shaft.[1]

The nutrient artery that supplies the radius arises from the anterior or posterior interosseous artery. This artery enters the bone through the nutrient foramen in the second proximal quarter of the diaphysis from the anterior to medial direction and follows an ascending course. In a typical long bone, blood supply comes from three separate systems: the nutrient artery, periosteal vessels, and epiphyseal vessels. The diaphysis and metaphysis are primarily nourished by the nutrient artery, which penetrates the cortex into the medullary cavity and then spreads outward through Haversian and Volkmans canals to supply the cortex. Extensive vessels in the periosteum provide blood supply to the superficial layers of the cortex and connect with the nutrient artery system. The epiphyses are supplied by a separate system, consisting of a ring of arteries entering the bone along a circular band between the growth plate and the joint capsule. In adults, these vessels connect to the other two systems at the metaphyseal-epiphyseal junction. However, while the growth plate is open, there is no such connection, and the epiphyseal vessels are the sole source of nutrition for the growing cartilage, making them essential for skeletal growth.

The diaphysis and metaphysis receive their primary nourishment from the nutrient artery, passing through larger or smaller foramina present in the shafts of long bones. These foramina are called nutrient foramina, and they lead into a nutrient canal. This vascular channel is a small tunnel through which the nutrient artery passes through the cortex into the medullary cavity and then ramifies outward through Haversian and Volkmans canals to supply the cortex. This osseous circulation provides nourishment to the living bone tissue, marrow, perichondrium, epiphyseal cartilages in young bones, and partly the articular cartilages.[2]

The healing of bones following fractures depends on their blood supply. This study on the vascularity of the radius will be helpful in reconstructive surgeries and bone transplants to assess the prognosis.

MATERIALS AND METHODS

The study was conducted using 50 dry human radii collected from the Department of Anatomy, Rajah Muthiah Medical College, Chidambaram, and Government Erode Medical College, Perundurai. Bones were collected irrespective of age, sex, and race, while damaged bones were excluded from the study. The side of the radius was first determined, and then each bone was inspected. The number, position, and direction of the foramen were noted with a probe in each bone. The results obtained were tabulated for analysis.

RESULTS

Out of the fifty radii studied, a single foramen was observed in the upper two-thirds of the anterior surface of the radius in forty-six bones. Among these forty-six, in two radii, the foramen was seen close to the anterior border. In another two radii, it was located on the posterior surface, and in one, it was found on the lateral surface. The nutrient foramen was consistently directed upwards in all radii. The study examined 50 bones, comprising 22 right-side radii and 28 left-side radii. Among these, 49 radii showed the presence of the nutrient foramen, while only one radius had an absent nutrient foramen. The examination revealed varying positions of the nutrient foramen. On the Anterior Surface, 20 nutrient foramina were observed in the right-side bones, while 26 were found in the left-side bones. The Posterior Surface showed a single nutrient foramen each in both the right and left-side bones. Interestingly, only the right-side bones had a nutrient foramen on the Lateral Surface, with no presence on the left side. Additionally, one bone on the left side showed an absence of the nutrient foramen. Overall, the study provided valuable insights into the distribution and presence of the nutrient foramen on different surfaces of the examined radii.

Figure 1:

Figure 2:

Table 1:

No. Of Bones Examined	Right	left	No. of Radius in which Foramen is Present	No. of Radius in which Foramen is Absent
50	22	28	49	1

Table 2:

Position of foramen	Right	Left
Anterior Surface	20	26
Posterior Surface	1	1
Lateral Surface	1	0
Absent	0	1
Total	22	28

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Figure 3:

DISCUSSION

Embryological Significance

Bone, or osseous tissue, is the hardest tissue in the body and requires constant blood supply as it is a living tissue. During embryonic development, in enchondral ossification, a periosteal bud, which is a vascular connective tissue bud from the perichondrium, enters the cartilage of a developing long bone and contributes to the formation of a center for ossification. This bud excavates the newly formed bone to allow the nutrient artery to enter the calcified matrix, creating a nutrient canal.2 The vascular supply of a long bone depends on several points of inflow, feeding complex, and regionally variable sinusoidal networks within it, which drain into venous channels on all surfaces not covered by articular cartilage. One or two main diaphyseal nutrient arteries enter the shaft obliquely through nutrient foramina, leading into nutrient canals. The nutrient arteries do not branch in their canals but divide into ascending and descending branches in the medullary cavity, supplying the cortex and the growing ends of the bone.

Direction of Canal

In the human embryo, around the 8th week of development, a vascular invasion occurs into the cartilaginous precursor of a long bone, perpendicular to the long axis of the bone's shaft. This leads to changes in bone morphogenesis, with longitudinal growth occurring mainly at the bone extremities. Consequently, there is a displacement of the location of the nutrient foramen, obliquity of the nutrient canal, and nutrient vessels. The direction of the nutrient foramina in human long bones is directed away from the growing end due to unequal growth of the ends of the long bones. The forces responsible for the determination of the direction of the nutrient canal are difficult to ascertain, but it is a necessary consequence of the mode of growth in length of the bone. In the present study, the nutrient foramen was consistently directed towards the upper end in all the bones studied.[3-5]

Number and Position of Nutrient Foramina:

The position of the nutrient foramen can be affected by the growth rates at the two ends of the bone shaft and bone remodeling. The absence of nutrient foramina in the radial diaphysis has been observed in previous studies. In the present study, most bones had a single nutrient foramen, mainly located in the upper two-thirds of the shaft, supplying bones at the site of muscle attachment. Double nutrient foramen was not observed in any of the bones studied.[5-12]

Radiological and Clinical Significance:

The foramina can mimic oblique fractures on plain radiographs, as the nutrient artery enters the bone through an obliquely oriented canal. The exact location and distribution of the nutrient foramina are crucial to avoid damaging the nutrient vessels during surgical procedures. Understanding the position and number of nutrient foramina is essential in orthopedic surgical procedures like joint replacement therapy, fracture therapy, bone grafts, and vascularized bone microsurgery. Injury to the nutrient artery during fracture or manipulation can be a significant factor in faulty bone union, and preserving diaphyseal vascularization is important during bone grafting and surgical procedures.[13-15]

CONCLUSION

It is essential to be aware of the nutrient foramina during surgical procedures to preserve adequate circulation. Understanding the location and number of nutrient foramina in long bones is crucial in orthopedic surgical procedures, including joint replacement therapy, fracture repair, bone grafts, and vascularized bone microsurgery.

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