INTRODUCTION

Fibula is a long bone present on the lateral side of leg. It receives its own neuro-vascular bundle apart from the muscles attached to it. The nutrient artery to fibula arises from the peroneal artery which winds around the neck of fibula and descends down along the fibula deep to flexor hallucis longus. Near the middle of fibula, it gives off nutrient artery which enters the nutrient foramen, and ramify within the fibula. The direction of the nutrient foramina is determined by the growing end of the bone, which is supposed to grow at least twice as fast as the non-growing end. As a result, the nutrient vessels move away from the growing end of the bone. Information and details about nutrient foramina is of clinical importance, especially in surgical procedures like bone grafting and microsurgical vascularized bone transplantation.

Fibula can be transplanted with least complications to bridge the gaps or defects in bones from various causes. Fibula can be transplanted with its nutrient vessels which are anastomosed with the concomitant vessels near the recipient bone. The transplant being a living bone can unite with the recipient bone like an ordinary fracture fragments without serious problem. In removing tumors of mandible, the advantages of the free vascularized fibular flap include its ability to be shaped with relative ease and to be grafted at the same time when tumors are resected, with consequent reduction in operation time.

The topographical knowledge of the nutrient foramina of fibula is important to proceed with the free implant of the vascularized bone. In bone transplant surgeries, statistical data on the nutrient foramina distribution in long bones makes it possible for the surgeons to select the bone section levels in order to place the graft without damaging the nutrient arteries, preserving the diaphyseal vascularization and the transplant consolidation.

Distribution of the nutrient foramina and exact position in bone diaphysis is important to avoid damage to the nutrient vessels during orthopedic surgical procedures as fracture repair, bone grafting, vascularized bone microsurgery as well as in medico-legal cases.

The objective of present research was to study the diaphyseal nutrient foramina of dried fibulae morphometrically and topographically in Pakistani population. As microvascular bone transfer is becoming more popular, such data regarding nutrient foramina will be of importance to orthopaedic surgeons.

ABSTRACT

Objective: To study the diaphyseal Nutrient Foramina (NF) of dry Pakistani fibulae morphometrically and topographically.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: Anatomy Department, Allama Iqbal Medical College, Lahore, from December 2013 to April 2014.

Methodology: The materials comprised 168 dried fibulae, 80 of left side and 88 of right side. Length of bone and distance of NF from the proximal end was calculated by placing bones on osteometric board. The Foramen Index (FI) was calculated by applying the Hughes formula, dividing the distance of the foramen from the proximal end (DNF) by the total length of the bone (TL) which was multiplied by hundred FI = (DNF/TL) x 100.

Results: Eighty five bones (96.6%) of right side and 79 bones (98.8%) of left side had a single nutrient foramen. Mean length of left fibula was 34.690 ± 2.353 cms and of right fibula 34.905 ± 2.198 cms. Mean foramen index was 47.651 ± 7.601 on the left side and 50.283 ± 11.478 on the right side. In the right fibulae, type-1 foramen was present in one (1.13%) bone, type-2 was present in 77 (87.5%) bones and type-3 was found in 10 (11.36%) bones. In the left fibulae, type-1 foramen was not found in any bone, type-2 in 79 bones (98.75%) and type 3 in only 1 bone (1.25%).

Conclusion: This study provides important information on the topography of nutrient foramina of fibula in Pakistani population. As microvascular bone transfer is becoming more popular, such data regarding nutrient foramina will be of importance to orthopaedic surgeons.

Key Words: Diaphyseal nutrient foramen. Dry fibula. Foramen index. Pakistan.
study, 168 fibulae were selected, out of which 88 were of right side and 80 were of left side. The age and gender of the bones were not determined.

All the bones were macroscopically observed for the number, location and direction of the nutrient foramina by means of a magnifying lens. The nutrient foramina were identified by the presence of a well-marked groove leading to them and a prominent slightly raised edge at the commencement of the canal.

To determine the length of bones, each bone was placed on osteometric board and total length was recorded. The distance between the apex of the head of the fibula and the tip of the lateral malleolus was recorded.

For measurement of distance of nutrient foramen of fibula from the proximal end, nutrient foramen was located and bone was placed on osteometric board to note the distance of nutrient foramen from the proximal end of bone. The Foramen Index (FI) was calculated by applying the Hughes formula, dividing the distance of the foramen from the proximal end (D) by the total length of the bone (L) which was multiplied by hundred.10

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FI = \frac{DNF}{TL} \times 100
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where DNF=distance from the proximal end of the bone to the nutrient foramen; and TL=total bone length. The position of the foramina was divided into three types according to FI:11 type-1 had foramen index below 33.33, the foramen was in the proximal third of the bone. Type-2 had foramen index from 33.33 up to 66.66, the foramen was in the middle third of the bone. Type-3 had foramen index above 66.66, the foramen was in the distal third of the bone.

Data was entered and analyzed in SPSS version 18.0. Mean values and standard deviation was calculated for bone length and distance of nutrient foramen from proximal end. Foramen index was also calculated. Frequency and percentages were calculated for number and site of nutrient foramina.

**RESULTS**

A total of 168 fibulae were studied (88 right and 80 left fibulae) for topographical location of nutrient foramina and morphometry. Mean length of left fibula was 34.690 ± 2.353 cms and mean length of right fibula was 34.905 ± 2.198 cms. The mean foramen index on left side was 47.651 ± 7.601. The mean foramen index on the right side was 50.283 ± 11.478 (Table I). Eighty five bones (96.6%) of right side and 79 bones (98.8%) of left side showed nutrient foramen on posterior surface (Table II).

![Figure 1: Fibula placed on osteometric board for morphometry and topography of nutrient foramen.](image)

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<tr>
<th>Table I: Morphometrical analysis of diaphyseal nutrient foramen in dry Pakistani fibulae.</th>
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<td>Fibula</td>
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<th>Table II: Topographical analysis of diaphyseal nutrient foramen in dried Pakistani fibulae.</th>
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<td>Topographical location</td>
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<td>(NF Right fibula n = 91), (NF Left fibula n = 82)</td>
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<td>Total fibula (168)</td>
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<td>NF on lateral surface</td>
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<td>Right side (88)</td>
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<td>Left side (80)</td>
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On the right side, type-1 foramen was present in one (1.13%) bone, type-2 was present in 77 (87.5%) and type-3 was found in 10 (11.36%) bones. On the left side, type-1 foramen was not found in any bone, type-2 was found in 79 bones (98.75%) and type-3 nutrient foramen was found in only one bone (1.25%, Figure 2).

**DISCUSSION**

The main blood supply to long bones occurs through the nutrient arteries, which enter through the nutrient foramina. The knowledge about these foramina is of crucial importance during surgical procedures to preserve the circulation especially to the plastic surgeon for microvascular bone transfer surgeries. In free vascular bone grafting, the nutrient blood supply must be preserved to promote fracture repair. It is necessary for osteoblast and osteocyte survival, as well as facilitating graft healing in recipient.

In different populations, studies to determine the number, position, direction of nutrient foramen and foramen index of fibula have been done but no such study about topography and morphometry of fibulae was carried out previously in Pakistani population. The results of present study showed that 85 bones (96.6%) of right side and 79 bones (98.8%) of left side had single nutrient foramen. It was found that 3 bones (3.4%) of right side and only 1 bone (1.2%) of left side possessed double nutrient foramen. It was observed that 57 bones (62.6%) of right side and 48 bones (58.5%) of left side showed nutrient foramen on posterior surface.

In a study, Prashanth et al. found that 90.2% fibulae had single foramen and foramen was absent in 9.8%. The mean foraminal index was 49.2 for fibulae. Sixty percent of the fibulae had nutrient foramen at the 3/5th part. In a research study on Caucasians, McKee et al. observed that 6% of the bones had no apparent foramen and 96% of the foramina were in the middle third of the fibula, a finding similar to the present study. This study recommended that this segment of the shaft should be used for free vascularized fibular transfers to increase the likelihood of including the endosteal blood supply.

In a study on South Brazilian adults by Pereira et al., the mean foraminal index for fibula was 46.1%. This study recorded data related to the population of Southern Brazil, providing ethnic data to be used for comparison and that may help in surgical procedures and in the interpretation of radiological images. In a study in Indian population absence of nutrient foramen was observed in 12 (6%) fibulae, 86.5% (173) of the fibulae possessed single nutrient foramen, while 6.5% (13) of the fibulae possessed double nutrient foramina and 1% (2) fibula had triple foramen.

In a study, Kumar et al. found that out of the 177 bones, 30 specimens showed more than one foramen and direction of four foramina was going towards the growing end of the bone. In a study on Korean population, Choi et al. observed that the location of the nutrient foramen was just proximal to the midpoint. In a study, Kocabiyik et al. found that in 90% of specimens studied, there was single nutrient artery, 6.6% had double nutrient artery and in 3.3% no nutrient artery was observed.

Gumusburun et al. studied that out of 305 fibulae, 281 had single nutrient foramen, 12 had two and the remaining 12 had no foramen. The foramina were seen primarily on the posterior surface (48.36%) and in the middle third (98.00%) of the bone, a finding similar to present study. The mean foraminal index of the fibula was found to be 48.14. Kizilkanat et al. noted that foramina were located on the diaphysis in 26-83% of the overall length of the fibula in the Turkish Caucasian population. Zhu et al. studied thirty-four cadaveric lower extremities and they found that all specimens had single fibular nutrient artery. In a study on Indian population, Bilodi et al. observed that nutrient foramina of fibula were present more on posterior surface (29.62%), followed by 22.23% on the lateral surface and 21.16% on the medial surface.

**CONCLUSION**

As microvascular bone transfer is becoming more popular, data regarding nutrient foramina of fibulae is of importance to orthopedic surgeons. Findings of present study about the topography and morphometry of the nutrient foramina of fibula in Pakistani population may prove helpful to proceed with the free implant of the vascularized fibula.

**REFERENCES**


