ORIGINAL ARTICLE
DIAPHYSEAL NUTRIENT FORAMINA IN DRIED HUMAN ADULT LONG BONES OF LOWER LIMB IN PAKISTAN

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Background: osteogenesis needs circulation of blood in the bones. Bone growth, repair of fracture, maintenance of bone vitality and other injuries also need blood circulation in proper way. Blood is allowed to flow via holes in the diaphysis, which are called as nutrient foramina. Methods: The cross-sectional study was done in the department of Anatomy, Ayub and Khyber Medical College (Osteology Sections). The aim was to observe diaphyseal nutrient foramina in the human long bones of the lower limb. The study was done on 90 long bones of lower limb consisting of 30 femora, 30 tibiae and 30 fibulae. Of all these bones, sex was not determined. All the bones were macroscopically observed. For the number of the foramina, simple counting was done. The foraminae 1 mm away from the borders were counted. All positions were seen macroscopically. For direction and obliquity, stiff wire was used. Results: We studied 90 long bones of lower limb. About 80% of long bones of lower limb showed single nutrient foramina. About 18% of lower limb long bones showed two nutrient foraminae. In cases of femora nutrient foraminae were directed proximally. In cases of fibulae and tibiae most of the foramina were directed distally. Conclusion: the study has provided additional information on the foramina index, morphology and topography of the nutrient foramina. In the lower limb long bones, the anatomical data is important for the clinicians as the micro-vascular bone transfer is becoming popular. This morphological data can be used by the forensic experts in identification through different landmarks in bones development giving an aid in medicolegal work.

Keywords: Micro-vascular bone transfer; Topography; Femora; Tibiae; Proximally; Distally; Osteology; Diaphysis

INTRODUCTION
Skeleton of the human body consists of 213 bones, not including the sesamoid bones. Axial skeleton consists of 74 bones, appendicular skeleton consists of 126 bones. Ear bones are six in number.¹

The circulation of blood is necessary for the osteogenesis, maintenance of bone growth, bone vitality and repair of fracture and other injuries.² Long bones get their blood supply by three types of vessels. All these vessels anastomose with one another. Blood supply to cortex is done by nutrient artery (10%). 90% of the supply to bone marrow is done also by nutrient artery. The nutrient artery divides into descending and ascending branches after it gets inside diaphysis.³,⁴

Marrow Space is surrounded by dense and solid cortical bone. The bone marrow cavity is lined by a honey comb arrangement of trabecular bone consists of plates and rods of trabecular bone.⁵ The bone resorbing is done by the osteoclast cells. The precursor cells of the monocyte –macrophage system.⁶,⁷

Long bones of the lower limb in their shafts have holes which are called nutrient foramina. These foramina lead into nutrient canals. Through these canals blood supply is provided to the diaphysis of the long bones. These canals are also present in the irregular bones. Direction of the nutrient foramina is calculated by the growing end of the bones which grows at a faster pace as compared to the non-growing end. The nutrient vessels move away from the growing end.⁸,⁹ It is very important to preserve Nutrient blood supply in bone grafts in order to promote fracture healing.¹⁰ Position of fractures is important in relation to nutrient foramina and healing especially in relation to nailing procedures in long.¹¹,¹²

This morphological information regarding nutrient foramen location in adult long bones is also important for bones identification in skeletal remains where identification of individual can be made from skeletal remains.¹³,¹⁴

MATERIAL AND METHODS
The cross-sectional study in the department of Anatomy, Ayub and Khyber Medical College (Osteology Sections) was done with the due permissions from the heads of the departments. The aim was to observe diaphyseal nutrient foramina in the human long bones of the lower limb. The study was done on 90 long bones of lower limb consisting of 30 femora, 30 tibiae and 30 fibulae. Of all these bones, sex was not determined. All the bones were macroscopically observed. For the number of the foraminae, simple counting was done. The foraminae 1 mm away from the borders were counted. All
positions were seen macroscopically. For direction and obliquity, stiff wire was used.

RESULTS
Of all the fibulae (30) that were examined, 81.25% had one nutrient foramina. Among them, 77.1% nutrient foramina were directed distally. Only 22.2% were directed proximally. Similarly, 46.6% of the femora had one nutrient foramina. 53.4% had two nutrient foramina. All the foramina were directed distally. In all the tibii, there was only one nutrient forama. All nutrient foramina were directed distally.

Table-1: Number of diaphyseal nutrient foramina seen in long bones of lower limb

<table>
<thead>
<tr>
<th>Bone</th>
<th>Number of bone</th>
<th>Number of Foramina</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur (n=30)</td>
<td>14</td>
<td>1</td>
<td>46.6</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>2</td>
<td>53.4</td>
</tr>
<tr>
<td>Tibia (n=30)</td>
<td>30</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Fibula (n=30)</td>
<td>26</td>
<td>1</td>
<td>81.29</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>18.75</td>
</tr>
</tbody>
</table>

Table-2: Direction and position of diaphyseal nutrient foramina in long bones of lower limb

<table>
<thead>
<tr>
<th>Bone</th>
<th>Position</th>
<th>Type-1</th>
<th>Type-2</th>
<th>Type-3</th>
<th>Direction of Foramina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td></td>
<td>10 (20.8%)</td>
<td>38 (79.16%)</td>
<td>-</td>
<td>Proximally</td>
</tr>
<tr>
<td>Tibia</td>
<td></td>
<td>25 (83.3%)</td>
<td>5 (16.6%)</td>
<td>-</td>
<td>Distally</td>
</tr>
<tr>
<td>Fibula</td>
<td></td>
<td>-</td>
<td>35 (97.2%)</td>
<td>1(2.7%)</td>
<td>28 Distally 8 Proximally</td>
</tr>
</tbody>
</table>

DISCUSSION
Nutrient foramina or nutrient canal has a particular position for each long bone of lower limb. It is directed towards the upper end of femur and lower ends of tibia and fibula. In the present study, we studied 30 femora. Single nutrient foramina were observed in 46.6%, 53.4% showed double nutrient foramina. Previous studies by Kizel Kanat et al showed that majority of the femora had single nutrient foramina. They also observed three foramina in some femora Collipal. We did not find that. They also observed up to six nutrient foramina in some femurs, Sendemir and Scimen. Some studies by Gumsburun et al and Motabagani showed no nutrient foramina in some femurs, we did not observe that. The present study showed single foramina in all the tibia. It is in accordance with the previous studies. 81.29% of fibulae had one nutrient foramina while 18.7% of the fibulae had two nutrient foramina. In some previous studies by Campos et al they observed that almost all the fibula had single nutrient foramina. In cases of femora all the nutrient foramina were directed proximally. In previous studies 0.5–1% nutrient foramina were directed distally. Our study on tibia was matching with the previous studies. Similarly, we matched with the previous study on fibulae that the nutrient foramina were directed towards the lower end.

CONCLUSION
Through our study we confirmed the previous results of number of foramina and direction of nutrient foramina (nutrient canal) in the long bones of lower limb. This study also provided us some useful information regarding the nutrient foraminae which can be used by clinicians specially the orthopaedic surgeons to avoid damage to the nutrient vessels supplying the long bones of the lower limb.

This information is an aid in forensic medicolegal work of human in skeletal remains identification in Mass disasters and another human skeleton discovery.

AUTHOR'S CONTRIBUTION
EA, FS, OK: Concept and design. Collection and assembly of data. NS: Interpretation of data.

REFERENCES

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