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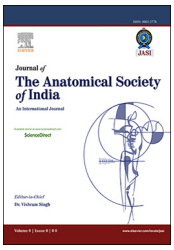

Original Article

A study of human diaphyseal nutrient foramina in fibula

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ABSTRACT

Introduction: Nutrient foramen is the external opening of the nutrient canal in a bone. The main blood supply to long bones is from nutrient arteries, especially during the active growing period in the embryo and during the early phases of ossification. An understanding of the location, number, direction, and caliber of diaphyseal nutrient foramina in fibula is very important clinically, especially in orthopedic surgical procedures.
Method: This study was conducted on 251 fibula (135 right and 116 left), macerated specimens of adult human fibula. Using osteometric board, Vernier calipers, hypodermic needles of size 20G and 24G, steel measuring scale, hand lens, and other basic instruments, all the parameters like average number, average distance of the nutrient foramen from the upper end of fibula, 'foraminal index', the most common location and the frequency of the location on the anatomical surfaces and borders of each of the fibula, the caliber, and the direction of each diaphyseal nutrient foramina were studied.
Results: The average number of diaphyseal nutrient foramina found in fibulas was 0.9.
Discussion: The foraminal index for the fibula, was 44.12%. All the nutrient foramina were on the posterior surface in fibulae, out of which 51.8% were found on the surface posterior to medial crest in the fibulae. In 21 out of the 251 fibula bones the nutrient foramina were found directed upwards. The fibula had only 3.18% dominant foramina.

1. Introduction

All arteries supplying the bone are 'nutrient' but the artery to the diaphysis has been known as 'nutrient artery' by most authorities. The original artery, which accompanies the initial invasion of the primitive cartilaginous rod by osteoclasts and osteoblasts, enlarges and persists as the nutrient artery. Bone is deposited round the vessel, thus forming a permanent track, which traverses the compact tissue thus forming a 'Nutrient canal'. Nutrient foramen is the external opening of the nutrient canal in a bone. The principal nutrient foramen is commonly displaced nearer to one extremity of a long bone than the other, and the canal is usually oblique with respect to

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the long axis of the bone. Berard[1] was the first to point out that in the human long bones the nutrient canals were obliquely disposed, pointing towards the elbow in the upper limb and away from the knee in the lower limb. The dissection room jingle ''*To the elbow I go; from the knee I flee*'' is originally in French, ''Au coude je m'appuis, du genou je m'en fuis''. This is called the Berard's rule of canal direction.

Investigations on the vascular anatomy of long bones were in the past confined mostly to animals. A few authors have studied nutrient foramina in human long bones, including the fibula.[3,4] Some authors have studied the lower limb long bones, including the fibula.[5–10] Few have studied the nutrient foramina of fibula particularly.[11,12] In this study, we examine in detail the diaphyseal nutrient foramina in 251 fibula, which is the largest sample size studied, and also study a new parameter – the 'caliber' of the foramina.

2. Material and method

This study was conducted on 251 fibula (135 right and 116 left), macerated specimens of adult human fibula, available in bone store of Government Medical College, Surat. These were of Indian Gujarati race and of unknown sex. The instruments used for the study were an Osteometric board, Vernier Calipers, Hypodermic Needles of size 20G and 24G, Steel Measuring Scale, Hand lens, Divider, marking pen, etc.

Each fibula was numbered serially with a marking pen to help in identification. Their side (left or right) was determined. The diaphyseal nutrient foramina were observed in all the bones with a hand-lens and encircled with a black marker pen. Various parameters were recorded for each of the fibulas, and the nutrient foramen and all values are recorded in centimeters. Only the diaphyseal nutrient foramina were studied and other foramina like epiphyseal were excluded. The following methodology was used to study the parameters.

2.1. *The total length (TL)*

The total length (TL) of each fibula was measured with the help of osteometric board and recorded to the nearest millimeter. Determination of the total length of the individual bones was done by taking the measurement between the apex of the head of the fibula and the distal aspect of the lateral malleolus.

2.2. *Total number of nutrient foramina*

The diaphyseal nutrient foramina were observed in all the bones carefully with a hand-lens and the total number of foramina present on any surface or border was recorded. In bones where there was doubt as to the nature of a foramen, a fine wire was passed through it to confirm that it did enter the medullary cavity. Foramina at the ends of the bone were not taken into account.

2.3. *The distance of the foramen or foramina from the upper end of the bone (DNF) and calculation of foraminal index*

The distance of the foramen or foramina from the upper end of the bone was measured by means of Vernier sliding calipers and recorded as DNF. The range of distance of nutrient foramen from upper end and the mean of distance of nutrient foramen from upper end were obtained and recorded. The foraminal index (FI) for each nutrient foramen was obtained using the formula: FI = DNF/TL $\times$ 100, where DNF was the distance from the proximal end of the fibula to the nutrient foramina, and TL was the total bone length. Thereafter, the mean of foraminal index, least foraminal index, and the highest foraminal index for fibula were determined and recorded.

2.4. *The location of nutrient foramen*

All the surfaces of the bones were scrutinized in a regular order. Foramina within 1 mm from any border were taken to be lying on that border. The descriptive term used for the surface and borders of the diaphysis of each fibula was recorded according to the Gray's textbook of anatomy,[13] for uniformity and standardization. The location of the nutrient foramina was also recorded in terms of the fraction of the bone it occupied from the upper end. For this, the fibula were divided into three equal fractions from above downwards and denoted as I, II, and III.

2.5. *The directions of the nutrient foramina*

The directions of the obliquity of the nutrient foramina and their canals were noted. A long fine needle was passed through the nutrient foramen and canal, to ascertain the direction of the canal. It was recorded as 'up' or 'down' with respect to the proximal end of the fibula being up.

2.6. *Caliber of the foramen and canal*

Hypodermic needles of 20G and 24G were used to measure the caliber of the foramen and canal. If the size 20G passed through the nutrient foramen satisfactorily, it was classified as 'Large' sized. If the needle of size 24G passed through the foramen and the size 20G did not pass through, the nutrient foramen was classified as 'Middle' sized. Both large and middle-sized foramina were also categorized as being Dominant. If the needle of size 24G could not pass through the foramen it was classified as 'Small' sized or 'Secondary' nutrient foramen.

After measuring all the bones, the 'Range' and the 'Mean' of measurements were obtained.

3. Result

The total number of fibula bones examined was 251; of which, 135 were of right and 116 were of left side. The detailed observation is summarized in Tables 1–3, and illustrated in Photo 1.

4. Discussion

On detailed study of our findings and comparing with the existing literature, we present the following analysis. The mean total length of the fibula is found to be 35.83 cm, the right