COMPARISON OF ULNATO FIBULA WITH RESPECT TO MORPHOLOGY AND TOPOGRAPHY OF NUTRIENT FORAMEN

ABSTRACT

Bones are the structure that adapt to their mechanical environment, and from fetal age they adapt to the presence of naturally occurring holes, known as nutrient foramen, which allow blood vessels to pass through bone cortex (1). Nutrient arteries is the principal source of blood to a long bone mainly during the growing period and early phases of ossification. Nutrient foramina reflects bone vascularization, thus the knowledge of number, position, location and direction of these foramina is useful in orthopaedic surgical procedure, like joint replacement, fracture repair and vascularised bone grafts. Fibula is most commonly used for bone graft purposes. Ulna being homologous to fibula, the present study aims to compare ulna and fibula with respect to morphology and topography of diaphysial nutrient foramen.

MATERIALS & METHODS

This study was conducted in Department of Anatomy, GSVM Medical College, Kanpur. A total of 100 (50 right and 50 left) ulna and fibula were examined for number, position, location and direction of Nutrient Foramen. Foramina Index was calculated.

RESULTS

93% of ulna showed single nutrient foramen, 100% were present on anterior surface with the mean foramina index of 33.87 ± 3.49 whereas 78% of fibula showed single nutrient foramen, 97.5% foramen were present on posterior surface with mean foramina index of 45.86 ± 4.55.

CONCLUSION

The present study exhibited higher percentage of single nutrient foramen in both ulna and fibula, also they were positioned mostly on the flexor surface of middle one third of shaft of both the bones. Thus, it was an attempt to draw a parallel correlation between Ulna and Fibula for use as vascularised bone grafts in orthopaedic and plastic surgery.

INTRODUCTION

Nutrient foramen is an opening into the bone shaft which gives passage to nutrient artery. Nutrient artery is principal source of blood to a long bone during the growing period and early phase of ossification. Nutrient foramina reflects bone vascularization, thus the knowledge of number, position, location and direction of these foramina is useful in orthopaedic surgical procedure, like joint replacement, fracture repair and vascularised bone grafts.

AIMS & OBJECTIVE

Fibula is most commonly used for bone graft purposes. Ulna being homologous to fibula, the present study aims to compare ulna and fibula with respect to morphology and topography of diaphysial nutrient foramen.

MATERIAL & METHODS

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- The study was conducted in the Department of Anatomy, GSVM Medical College, Kanpur.

- A total of 100 (50 right and 50 left) ulna and fibula were examined.

- The following materials were used:
  - Magnifying lens
  - Bone Osteometer
  - Metallic measuring scale
  - Guide wires
  - 24 hypodermic needle (0.86 mm in diameter)
  - Digital camera for illustration.

- The Nutrient Foramina were observed in all bones with the help of a hand-lens.

- The location of only Dominant Foramina was considered and their distribution over different surface was observed by direct inspection.

- Foramina at the ends of the bone were ignored.

- Only well-defined Foramina on the diaphysis were accepted.

- The location of only Dominant Foramina was considered and their distribution in bone length was determined by calculating a Foramen Index (FI) using the formula:

\[ FI = \frac{DNF}{TL} \times 100 \]

Hughes, 1952; Shulman, 1959.

- FI = (DNF/TL) x 100

- DNF - The Distance from the proximal end of the bone to the Nutrient Foramen.

- TL - Total length of the bone.

- Depending on foramina index, the location of nutrient foramen in relation to length of bone is classified as:
  - Type 1 (0-33% of bone length)
  - Type 2 (33%-66% of bone length)
  - Type 3 (66%-99% of bone length)

- Results

- **NUMBER OF NUTRIENT FORAMEN**

- **Ulna**
  - On right side, out of 50 bone, 46(92%) bones show single foramen and 4(8%) bones show double foramen.
  - On left side, out of 50 bone, 47(94%) bones show single foramen and 3(6%) bones show double foramen.

- **Fibula**
  - 100% of bones show single foramen, 100% are present on anterior surface with mean foramina index of 33.87 ± 3.49.

- **DISCUSSION**

- Vascularized fibular grafts (VFG) are most commonly used for reconstructive surgeries. The advantage of free vascularised fibular grafts include its ability to be shaped with relatively ease is known, and has been used for reconstructing a large bony defects like mandibulotomy after hemimandibulectomy. In transplant techniques, the use of statistical data on the nutrient foramina distribution in long bones makes it possible for the professional to select the osseous section levels of the receptor in order to place the graft without damaging the nutrient arteries, preserving, thus, the diaphysial vascularisation (8). However, there is still a need for a greater understanding of the morphology and morphometry of nutrient foramina in other long bones. Since Ulna is homologous bone to topography of nutrient foramen.

- **CONCLUSION**

- This study was conducted in Department of Anatomy, G.S.V.M. Medical College, Kanpur. A total of 100 (50 right and 50 left) adult human fibula and 100 (50 right and 50 left) ulna were examined in the department. Following materials were used:
  - a) Magnifying lens
  - b) Bone Osteometer
  - c) Metallic measuring scale
  - d) Guide wires
  - e) 24 hypodermic needle (0.86 mm in diameter)
  - f) Digital camera for illustration.

- With the help of above instruments, the following observations were done:
  1. **Number of Nutrient Foramina**: The Nutrient Foramina were observed in all bones with the help of a hand-lens. They were identified by their elevated margins and by the presence of a distinct groove proximal to them. Only well-defined Foramina on the diaphysis were accepted. Foramina at the ends of the bone were ignored.
  2. **Position of Nutrient Foramina**: Of all the Foramen present their distribution over different surface was observed by direct inspection.
  3. **Location of Nutrient Foramina**: The location of only Dominant Foramina was considered and their distribution in bone length was determined by calculating a Foramen Index (FI) using the formula:

\[ FI = \frac{DNF}{TL} \times 100 \]

Hughes, 1952; Shulman, 1959.

- **RESULTS**

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**Fibula:** On right side, out of 50 bone, 40(80%) bones shows single foramen and 10(20%) bones shows double foramen. On left side, out of 50 bone, 38(76%) bones shows single foramen and 12(24%) bones shows double foramen.

**POSITION OF NUTRIENT FORAMEN IN LONG BONE**

**Ulna:** In ulna both on the right and left side all the foramina (100%) were present on anterior surface.

**Fibula:** On right side, out of 60 foramen, 59(98.3%) foramen was present on posterior surface and 1(1.6%) was present on medial crest. On left side, out of 62 foramen 60(96.7%) of foramen was present on posterior surface and 2(3.2%) was present on medial crest.

**LOCATION OF NUTRIENT FORAMEN**

**Ulna:** On right side, out of 50 foramen, 21(42%) dominant foramen were of type I and 29(58%) were of type II. On left side, out of 49 dominant foramen, 20(40.8%) were of type I and 29(59.2%) were of type II.

**Fibula:** Both on the right and left side all the foramen (100%) were of type I.

**Table 1 Showing Morphometric & Topographic Observations Of Nutrient Foramen In Ulna**

<table>
<thead>
<tr>
<th>S.N</th>
<th>Parameter</th>
<th>Right (n=50)</th>
<th>Left (n=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of foramina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>46(92%)</td>
<td>47(94%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4(8%)</td>
<td>3(6%)</td>
<td></td>
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<tr>
<td>&gt;2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>P value &gt;0.05 not significant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Position of Nutrient Foramen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anterior Surface</td>
<td>54(100%)</td>
<td>53(100%)</td>
</tr>
<tr>
<td></td>
<td>Medial Surface</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>P value &gt;0.05 not significant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Location of Dominant Foramen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type I</td>
<td>21 (42.0%)</td>
<td>20 (40.8%)</td>
</tr>
<tr>
<td></td>
<td>Type II</td>
<td>29(58%)</td>
<td>29(59.2%)</td>
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<tr>
<td></td>
<td>Type III</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>P value &gt;0.05 not significant</td>
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<td></td>
</tr>
</tbody>
</table>
DISCUSSION

Vascularized fibular grafts have been used for mandibular reconstruction. (11,12,13) used extensively in orthopaedic and plastic surgery. The advantage of free vascularized fibular flap include its ability to be shaped with relative ease and to be grafted at the same time tumors are resected, with consequent reduction in operation time. In addition, few complication occurs at donor site. Healing of fractures, as of all wounds, is dependent upon blood supply((14,15)). If surgeon could avoid a limited area of the cortex of the long bone containing nutrient foramen, particularly during an open reduction, an improvement in the management of this problem might be attained. Thus, knowledge of anatomy of nutrient foramen is significantly important for orthopaedic surgeons doing open reduction of fracture, in order to avoid injuring nutrient artery and there by lessens the chances of delayed or non union (16).

The major blood supply to long bones usually enter at particular points on the shaft that determines the number of nutrient foramen. An absence of nutrient foramina in long bones has been constant feature, and in these cases the periosteal vessels become the sole source of blood supply(10,17,18). For Ulna, Forriol, 1987; Nagel, 1953 reported all the bones studied with single nutrient Foramen. In the present study, 93% of Ulna shows single Nutrient Foramen and 7% with double foramen which is in agreement with Shulman, 1959; Longia et al., 1980. In the Fibulae studied, 78% of bone presented a single nutrient foramen and 22% of bone with double foramen similar to studies of Mysorekar, 1967; Longia et al1980; Sendemir and Cimen, 1991.

Longia et al, 1980 observed that the position of nutrient foramen on flexor aspect in their human long bone specimens. Kizilkant et al., 2007 stated that the position of nutrient foramen was directly related to requirement of continuous blood supply to specific aspects of each bone, where there were major muscle attachments. Forriol Campos et al., 1987; Shulman, 1959; Kizilkant et al., 2007 reported all the Ulna, in their study, present on anterior surface, which is in agreement with present study. In this study, 90.75% of foramen anterior surface. In Fibula, 97.5% of foramen were present on posterior surface and 2.4% on medial crest.

There is variations in the distribution of Nutrient Foramina and this is important preoperatively especially regarding fibula, used in bone grafting. Regarding Ulna, in present study,42% were located were located in proximal one third and 54.9% were present in middle one third similar to Mysorekar, 1967. This is in disagreement with previous studies of Shulman, 1959; Longia et al., 1980. For Fibula, Guo, 1981 reported majority of foramina located in upper one third, whereas in all other studies, they were located in middle one third. In present study, all foramen were located in middle one third of bone length with foramina index between 56.3% to 58.2%.

CONCLUSION

In the study we found that 93% of ulna showed single nutrient foramen, and is most commonly located on anterior surface (90.75%) in the middle third of shaft. For Fibulae, 78% of bone presented single nutrient foramen, 97% of foramen were present on posterior surface and in some of the case it is located in medial crest (2.5%). Our research about correlation of nutrient foramina of ulna will be helpful to orthopaedic and plastic surgeons.

REFERENCES