Morphometric study of human fibular incisura in dry bones

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Abstract

Aims & Objectives: Intersosseous border of tibia splits distally into anterior and posterior edges. These edges project into anterior and posterior tubercles enclosing a notch called fibular incisura that articulates with the distal fibula forming distal tibiofibular syndesmosis. The aim of the present study was to obtain the morphometric data of fibular incisura that may be helpful for the orthopedic surgeons in ankle reconstructive surgeries and ankle joint replacement. Materials & Method: To describe the morphometry of the fibular incisura, a total of 100 tibia [right 55 and left 45] were obtained from the Department of Anatomy, NRI Medical College, Chinakakani. The width of tibia, width, depth, height of fibular incisura and the length of anterior, posterior incisural tubercles were measured in both right and left tibia using digital vernier calipers. Right and left side para meters were compared using Karl Pearson Coefficient [r value]. Results: Average values for the width, depth and height of the fibular incisura were 16.83mm on the right side and 17.42mm on the left side, 2.85±1.38mm on the right and 2.9±1.57mm on the left side, 38.8±5.88mm on the right side and 38.72±7.68 mm on the left side respectively. While average lengths of anterior and posterior tubercles of the fibular incisura were 13.19±1.96mm, 15.71±2.03mm on the right side and 12.6±1.49mm, 15.66±1.41mm on left side. Thirty-three tibia presented deeply concave [depth>4cm], and sixty-seven had shallow fibular incisura [depth<4cm]. Conclusion: The morphometry and anatomical variability of fibular incisura should be taken to account in assessing radiographs, CT and MRI of talocrural joint.

Keywords: fibular incisura, syndesmosis, morphometry, peroneal groove

Introduction

Intersosseous border of tibia splits distally into anterior and posterior edges. These edges project into anterior and posterior tubercles enclosing a notch, fibular notch or fibular incisura [FI]. FI articulates with the distal fibula forming distal tibiofibular syndesmosis. The anterior and posterior tibiofibular ligaments, intersosseous ligament and inferior tibiofibular ligament stabilizes this joint. FI, present on the lateral surface of lower end of tibia plays an important role in forming the inferior tibiofibular syndesmosis. The morphometric data of this notch is important in assessing the stability of the inferior tibiofibular joint which in turn maintains the stability of ankle joint. This notch is also called the peroneal groove or fibular notch or fibular incisura or syndesmotic notch.14

Distal tibiofibular syndesmosis along with medial malleolus and lateral malleolus forms tibiofibular mortise that articulate with talus forming ankle joint. The FI and the distal fibula form an anatomical unit whose stability depends largely on morphometry of FI. Morphometric analysis of FI find clinical application in imaging diagnostics of ankle joint and interpretation of imaging techniques like plain radiographs, CT and MR images. The study of FI measurements helps the orthopedic surgeons in ankle reconstructive surgeries [open reduction and internal fixation of the fracture dislocation of the ankle mortise] and the measurements may play a pivot role in ankle joint replacement.

The aim of the present study was to determine the morphometric data of fibular incisura.

Materials & Method

Present study was done on 100 dry adult tibia [right 55, left 45] collected from the Department of Anatomy,
NRI Medical College, Chinakakani, Guntur, A.P. Gender and age of the bones were not considered. Damaged and abnormal bones were excluded from the study. Vernier calipers and goniometer were used for linear and angular measurements respectively.

The following parameters were taken at the level of a points 1cm above the tibial plafond. All measurements were in millimeters [mm].

1. Width of tibia [between medial & lateral borders of tibia]
2. Width of fibular incisura: between anterior and posterior tubercles [Fig:1]
3. Depth of fibular incisura: from the deepest point of the incisura to the midpoint of the line between anterior & posterior tubercles [Fig:2]
4. Length of anterior facet: from the tip of the anterior tubercle to the deepest point of fibular incisura
5. Length of posterior facet: from the tip of posterior tubercle and the deepest point of fibular incisura
6. Angle between the anterior and posterior facets [in degree].
7. Height of fibular incisura: vertical distance between the tibial plafond and the point where interosseous border splits into anterior and posterior edges [Fig:3].

Mean, minimum, maximum and standard deviation values were calculated and the data was subjected to Karl Pearson correlation test \[ r \] value to find out any significant correlation among the different parameters on the same side and for comparison between right and left sides.

**Results**

All 100 bones were studied. The mean width of FI was 17.1 mm, the depth of FI was 2.8 mm, length of anterior and posterior facet was found to be 12.8 mm and 15.6 mm respectively. Angle between anterior and posterior facet was 125.3°. Mean height was 38.7 mm. Table 1 and 2 tabulates the morphometric data from right and left sides respectively.

Karl Pearson correlation coefficient that denotes strength of relationship between two variables was used and denoted by \( r \). There was highly significant correlation between length of anterior facet and length of posterior facet \([r, 0.46 \& p, 0.00001]\). There was a weak positive correction between width of tibia and width of FI \([r,0.22 \& p,0.02]\). There was significant correlation between width of fibular incisura and depth of FI \([r, 0.326 \& p, 0.0009]\). There was no correlation between depth of fibular incisura and height of FI \([r, 0.06 \& p, 0.55]\). There was significant weak positive

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**Fig. 1**: Showing the measurement of width [A], depth [B] and [C] height of fibular incisura
Table 1: Measurements of right fibular incisura 1 cm proximal to the tibial plafond (in mm)

<table>
<thead>
<tr>
<th>Measurement point</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
<th>Z-test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of tibia</td>
<td>31.2</td>
<td>44.6</td>
<td>39.61</td>
<td>3.11</td>
<td>0.97</td>
<td>0.32</td>
</tr>
<tr>
<td>Width of FI</td>
<td>13.6</td>
<td>23.0</td>
<td>17.42</td>
<td>2.29</td>
<td>1.37</td>
<td>0.17</td>
</tr>
<tr>
<td>Depth of FI</td>
<td>0.5</td>
<td>4.94</td>
<td>2.85</td>
<td>1.38</td>
<td>0.167</td>
<td>0.86</td>
</tr>
<tr>
<td>Length of anterior facet</td>
<td>8.7</td>
<td>17.9</td>
<td>13.19</td>
<td>1.96</td>
<td>1.709</td>
<td>0.08</td>
</tr>
<tr>
<td>Length of posterior Facet</td>
<td>11.3</td>
<td>20.5</td>
<td>15.71</td>
<td>2.03</td>
<td>0.14</td>
<td>0.88</td>
</tr>
<tr>
<td>Angle between anterior and posterior Facet</td>
<td>123°</td>
<td>130°</td>
<td>124.6</td>
<td>6.34</td>
<td>0.76</td>
<td>0.44</td>
</tr>
<tr>
<td>Height of FI</td>
<td>28.3</td>
<td>53.3</td>
<td>38.82</td>
<td>5.58</td>
<td>0.073</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Table 2: Measurements of left fibular incisura 1 cm proximal to the tibial plafond (in mm)

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of tibia</td>
<td>33.9</td>
<td>49.2</td>
<td>40.24</td>
<td>3.29</td>
</tr>
<tr>
<td>Width of FI</td>
<td>14.0</td>
<td>21.4</td>
<td>16.83</td>
<td>2.01</td>
</tr>
<tr>
<td>Depth of FI</td>
<td>0.6</td>
<td>5.7</td>
<td>2.90</td>
<td>1.57</td>
</tr>
<tr>
<td>Length of anterior facet</td>
<td>10.1</td>
<td>15.4</td>
<td>12.6</td>
<td>1.49</td>
</tr>
<tr>
<td>Length of posterior facet</td>
<td>12.3</td>
<td>19.0</td>
<td>15.66</td>
<td>1.41</td>
</tr>
<tr>
<td>Angle between anterior &amp; posterior facet</td>
<td>121°</td>
<td>130°</td>
<td>126.1</td>
<td>8.24</td>
</tr>
<tr>
<td>Height of FI</td>
<td>26.4</td>
<td>57.9</td>
<td>38.72</td>
<td>7.68</td>
</tr>
</tbody>
</table>

Table 3: Comparison of depth of the fibular incisura in different population

<table>
<thead>
<tr>
<th>Study</th>
<th>Technique</th>
<th>Population</th>
<th>Mean Depth (mm) ± Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rachana 6</td>
<td>Direct bone measurement</td>
<td>Indian</td>
<td>6.22±1.46 (right side) 6.14±1.71 (left side)</td>
</tr>
<tr>
<td>Misiani 7</td>
<td>Direct bone measurement</td>
<td>Kenyans</td>
<td>3.44±0.87</td>
</tr>
<tr>
<td>Mavi et al 4</td>
<td>MRI</td>
<td>Turkish</td>
<td>3.6</td>
</tr>
<tr>
<td>Sora et al 11</td>
<td>Plastination study</td>
<td>Austrian</td>
<td>5.07±0.76</td>
</tr>
<tr>
<td>Kin et al 12</td>
<td>CT</td>
<td>Korean</td>
<td>3.1</td>
</tr>
<tr>
<td>Taser et al 5</td>
<td>Direct bone measurement</td>
<td>Turkish</td>
<td>3.68±1.49</td>
</tr>
<tr>
<td>Shivaji et al 8</td>
<td>Direct bone measurement</td>
<td>Indian</td>
<td>3.25±0.32</td>
</tr>
<tr>
<td>Present study</td>
<td>Direct bone measurement</td>
<td>Indian</td>
<td>2.85±1.38 (Right side) 2.90±1.57 (Left side)</td>
</tr>
</tbody>
</table>
correlation between width of fibrilar incisura and height of FI [r, 0.197 &p, 0.049]. There was weak positive correlation between the depth of FI and length of anterior facet [r, 0.0558 & p, 0.58] which is not significant. There was weak negative correlation between the depth of FI and angle of FI[r, -0.08p, 0.41] which is not significant.

Out of 55-right sided tibia, 21.8% [12] bones presented deeply concave [depth >4cm], and 78.18% [43] bones showed a shallow FI[depth < 4cm]. Out of 45-left sided tibia, 24.4% [11] bones presented deeply concave and 75.5% [34] bones showed a shallow FI.

Discussion:

An intact tibiofibular syndesmosis joint is important in maintaining the normal functioning of the ankle mortisise. The anatomical knowledge of tibiofibular syndesmosis is essential for the preoperative and postoperative assessments of ankle sprains and ankle fractures. This syndesmosis may be injured in ankle sprains with or without dislocation. Therefore, the articulation between fibula and fibrilar incisura is of prime importance in maintaining the structural and functional integrity of ankle mortisise. There are many CT and MRI studies on ankle mortisise. However, morphometric data from dry bones is less reported.

In the present study, the mean width of tibia on right side was 39.61mm and on the left side was 40.24mm. Similar observation was made by Taser[39.14± 2.75 mm] and Rachana[41.86±3.28 mm on right and 38.97±3.77mm on left side].

In the present study, the mean width of fibrilar incisura was 16.83 mm on the right side and 17.42 mm on the left side. In a study by Rachana et al the mean width of FI was 23.5±1.72, 23.11±1.90 on right and left sides respectively. Similar findings were reported by Taser[23.26±3.11mm], Misiani[21.50±2.37mm] and Shivaji[23.94±1.02mm].

Hermans et al described that the width of fibrilar incisura is the representative of the size of the tibiofibular syndesmosis. A wider incisura indicates a greater separation of the anterior and posterior incisural tubercles. This translates to a shallower incisura that predisposes an individual to the instability of tibiofibular syndesmosis as described by Hocker and Pachucki.

The length of anterior and posterior tubercles obtained in the present study correlates with Rachana et al who reported it as 11.59± 1.88, 14.79±2.57mm on the right side and 11.03±1.60,14.63 ± 2.23mm on the left side, Misiani[11.40± 1.89, 16.11±2.08mm] and Taser et al[10.89±2.08,13.28±1.49 mm] respectively. In the present study, the mean value of the angle between anterior and posterior facets was found to be 124.6° on the right side and 126.1° on the left side. In a study by Rachana et al angles were 128.8 ± 7.65, 131.06 ± 8 on right and left sides respectively. While it was 139° and 126° in the studies done by Mavi et al and Taser et al respectively. The results are correlating with the studies of Taser.

Average height of FI in the present study is 38.82± 5.58mm on right side and 38.72±7.68mm on left side. Misiani, Taser and Shivaji reported it as 32.35 ± 4.14mm 29.43 ± 4.07mm and 31.87±2.01mm respectively.

A shorter height of the FI indicates a lower bifurcation of the interosseous tibial ridge. Since the depth of the FI increases proximo-distally, a lower division of the interosseous tibial ridge results in a shallower, narrower FI.

In the present study it was found that 46% of fibrilar notches presented deeply concave fibrilar incisura, 54% of notches shows a shallow FI. But in a study by Ebraheim et al 60% presented a deeply concave and 40% shallow concave fibrilar notch while Taser et al in his study found 35% deeply concave 65% shallow concave fibrilar notch. Rachana et al observed 88.2% deeply concave and 11.8% shallow concave notches and in the study by Misiani 25% deeply concave and 75% showed shallow concave fibrilar notches were noted.

Depth of FI in present study is 2.85±1.38 mm on the right side and 2.9±1.57 mm on the left side. These observation were similar to the observations by Shivaji et al [3.25±0.32 mm] but differed from Rachana et al
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[6.22±1.46 mm on the right side and 6.14±1.71 mm on the left side]. Misiani\textsuperscript{7} Taser\textsuperscript{5} reported it as 3.44±0.87 mm, 3.68±1.49 mm respectively [Table 3].

Shallow fibular incisurae have been implicated in the pathomechanics of displacement of the fibula associated with fracture dislocation that results in instability of the tibiofibular syndesmosis and the ankle joint\textsuperscript{6}.

Limitations of the study: The comparison between male and female could not be done as the age and sex of the bones were unknown in the present study.

Conclusion
The morphometry and anatomical variability of fibular incisura should be taken to account in assessing the stability of talocrural joint and to interpret radiographs, CT, MRI of tibio fibular syndesmosis and talocrural joint. This study will be helpful to orthopedic surgeons for placement of implants of appropriate dimensions in ankle reconstruction surgeries.

Acknowledgement
I am thankful to Mrs. Saritha who helped me in doing statistical analysis and Mrs. Rajyalakshmi for her technical assistance.

Date of submission : 21.02.2018
Date of acceptance : 15.03.2018
Conflicts of interest : None
Financial support : None

References

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