# The fibular incisura of the tibia with recurrent sprained ankle on magnetic resonance imaging

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ABSTRACT

**Objective:** The aim of this study was to investigate the fibular incisura of the tibia in type I and II recurrent sprained ankle.

**Methods:** A total of 18 limbs (9 right, 9 left) were examined for the fibular incisura of the tibia by magnetic resonance imaging at Gunmar Magnetic Resosnace Imagaing Center between September 2000 to May 2001. This group consisted of 10 males and 8 females and their age ranged between 18-61 years. The control group was made up of 75 participating volunteers without previous history of trauma in the ankle.

**Results:** The measurements of the length of the anterior and posterior facets, depth of the fibular incisura of the tibia and the distance between anterior margin of the tibia and anterior margin of the fibula in the patient group were visibly different from the measurements of the control group. In recurrent sprained ankle, the anterior and posterior tubercles were lengthier, the depth of the fibular incisura of the tibia was deeper and the fibula was more anterior than the control group. The measurements of the angle between anterior and posterior facets and the vertical distance of tibiofibular overlapping in the patient group were slight different from the measurements of the control groups.

**Conclusion:** These characteristics, which were observed in the recurrent sprained ankles, may be anatomically predisposed to recurrent ankle sprains.

**Keywords:** Fibular incisura of the tibia, incisural notch, recurrent ankle sprains.

**Saudi Med J 2002; Vol. 23 (7): 845-849**

The ankle joint is formed by the articulation of the talus with ankle mortise. The mortise is an inverted U formed by the lateral malleolus, the articular surface of the distal tibia. An intact mortise is critical in maintaining normal ankle function. The tibia and fibula articulate at their distal ends. This is a fibrous joint of the syndesmosis type.[1,2] A complex articulation is formed by the ligaments of the syndesmosis. This complex structure keeps the fibula in close proximity in the fibular incisura of the tibia (FIT) which is bordered by a broad anterior tubercle and a smaller posterior tubercle.[3-5] The FIT is called the incisural notch, fibular notch of the tibia, peroneal groove of the tibia or syndesmotic notch. The fibula is held in the joint by 4 ligaments;[4,6] the tibiofibular interosseus ligament, the anterior tibiofibular ligament, the posterior tibiofibular ligament and the transverse tibiofibular ligament. The tibiofibular interosseus ligament extends from the FIT to the medial surface of the distal end of the fibula and forms principal connection between the tibia and fibula at this joint. The anterior and

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Received 27th August 2001. Accepted for publication in final form 26th January 2002.

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posterior tibiofibular ligaments extend from the borders of the FIT to the anterior and posterior surface of the lateral malleolus. The inferior, deep part of the posterior tibiofibular ligament is called the transverse tibiofibular ligament. This strong band, closes the posterior angle between the tibia and fibula.

Intact distal syndesmosis is critical in maintaining normal ankle function. Distal syndesmosis may be injured in ankle sprains and fractures with or without dislocation. Ankle sprains were classified in 3 groups according to the degree of injury: 1) soft tissue injuries of the ankle joint occur as minor ligamentous injuries (Type I sprain), 2) incomplete ligamentous injuries (Type II sprain), and 3) complete disruption of the ligament (Type III).[7] Without adequate care, acute ankle trauma can result in chronic joint instability. Wolfe et al[8] reported that the use of a standardized protocol enhanced the management of ankle sprains. In patients with type I or II sprains, emphasis should been placed on accurate diagnosis, early use of rest, ice, compression and elevation (RICE), maintenance of range of motion and the use of ankle support. Type III sprains may require casting or surgical intervention. Wexler[9] emphasized a chronic ankle injury should prompt evaluation for other conditions, such as talar dome lesion. Espejo Baena et al[10] also reported that an unusual case of an area of necrosis on the talar neck of a girl with a 2-year history of gradually increasing pain following an ankle sprain. Arthroscopic removal of a necrotic fragment from the anterior talar neck that was impinging on the tibia relieved symptoms. Syndesmotic injury may be difficult to appreciate by radiographic criteria due to variations in the amount of rotation and in the depth of the FIT, and in the shape of the tibial tubercle.[3,11] The purpose of this article is to investigate the relationship of the distal tibia and fibula in the area of the syndesmosis of adult patients who had recurrent ankle sprains (type I and II) on magnetic resonance image (MRI).

**Methods.** Ten males and 8 females patients with type I and II recurrent ankle sprains were used. A total of 18 lower limbs (9 right, 9 left) were examined for the FIT by MRI at Gunmar Magnetic Resonance Imaging Center between September 2000 to May 2001. All the patients suffered 2 or more sprains. The ankle sprains of all the patients were type I and II. All patients had the treatment of RICE and healed after the treatment. All patients reported that they had not complained about pain, ecchymosis, swelling, areas of tenderness and laxity before their ankles was sprained. All patients had no associated fracture in their ankles. Data was collected on all participants including age, sex, weight, height and age range was 18-61. For the 10 males and the 8 females, the average height and weight were 1.70 cm, 67.5 kg and 1.63 cm, 75 kg. The control group was made up of 43 males and 32 female volunteers (150 lower limbs), all without previous history of trauma to the ankle, and their age range was 18-51. For the 43 males and the 32 females, the average height and weight were 1.74 cm, 71.5 kg and 1.61 cm, 61.2 kg. All specimens (control and patient groups) were examined by the Siemens magnetom impact model machine of MRI. Knee coil was used for all specimens. The fast low angle shot (Flash) weight scans were used for axial and sagittal views. The parameters, which were used for these scans, follows time of repeat 410ms, time to echo 18ms, flip angle (FA): 25, field of view (FOV): 16 cm, matrix: 128x256. The thickness of slice was 10mm. The sagittal scans were obtained when the position of ankle joint was neutral position in 90 degree of dorsal flexion. The axial views were taken one cm proximal to the tibiotalar joint line with the foot in neutral position when the tibiotalar joint was observed on the sagittal view (**Figure 1a**). The following parameters were measured on these axial views: a) length of the anterior facet, which was measured between the tip of the anterior tubercle and the deepest point of the FIT, b) length of the posterior facet, which was measured between the tip of the posterior tubercle and the deepest point of the FIT, c) angle between anterior and posterior facets, d) depth of the FIT, which was measured from the deepest point of the FIT to a line between tips of the anterior and posterior tubercles, e) vertical distance of tibiofibular overlapping (a line perpendicular to a reference line that is an extension line through the posterior facet), f) distance between anterior margin of the tibia and anterior margin of the fibula, g) interval between the deeper posterior portion of the fibular incisura and the adjacent fibula cortex (representing syndesmotic space rather than the narrowest measurement) (**Figure 1b**).[5] It was searched whether there is a relationship between these measurements and the sprain of ankle or gender. For statistical procedures, Student-t test and Mann Whitney-U test were used.

**Results.** Magnetic resonance imaging of the tibiofibular syndesmosis clearly demonstrated the tibial tubercles, the FIT and the interior of the tibiofibular space (**Figures 2a & 2b**). Results are shown in **Table 1**. It was observed that the length of the anterior (a) and posterior (b) facets, depth of the fibular incisura of the tibia (d) and distance between anterior margin of the tibia and anterior margin of the fibula (f) in the patient group were different with the result in the control group. However, in a, b, f values of man ($p<0.05$) and d value of woman ($p<0.05$), there were statistically significant differences. All the specimens (the recurrent sprained ankles and the ankles of control group) were concave. In the patient group, 9 specimens (90%) in man showed a significant concave of the FIT (4 mm

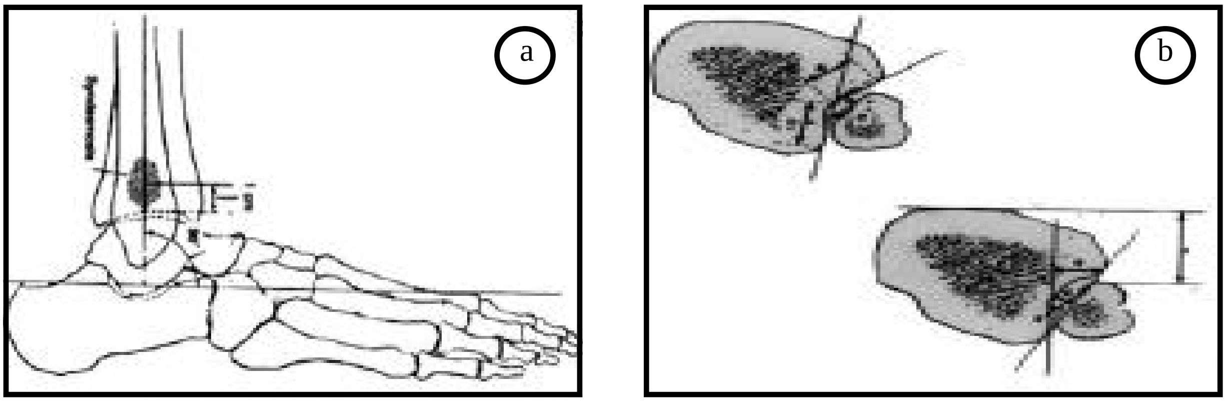


**Figure 1 -** Schematic illustration showing **a)** the position of the foot and the location of the axial cuts with respect to the tibiotalar joint line. **b)** the measurement of the fibular incisura of the tibia on the magnetic resonance imaging.

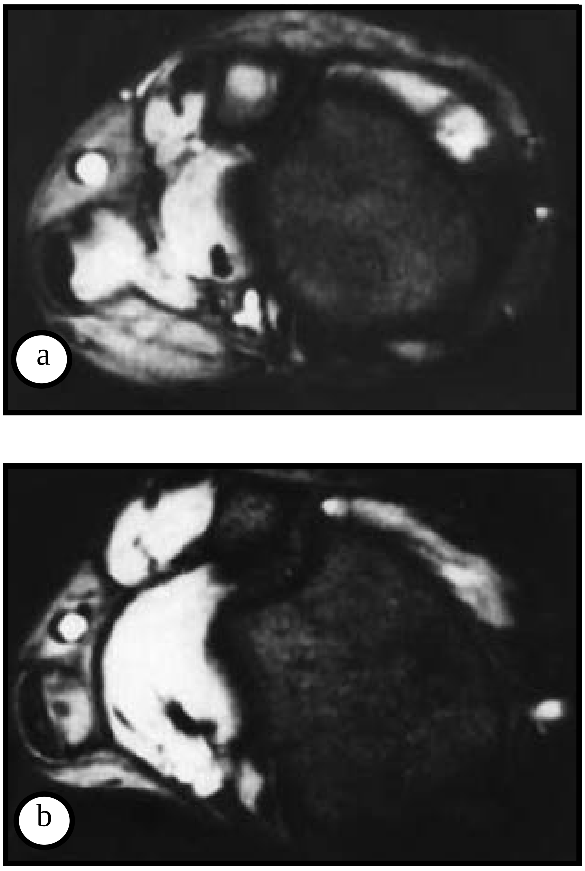


**Figure 2 -** Magnetic resonance showing **a)** the depths of the fibular incisura of the tibia was 2mm. **b)** the depth of the fibular incisura of the tibia was 5mm.

**Table 1 -** Magnetic resonance imaging measurements of the fibular incisura of the tibia for ankle.

| **Measurements** | **Male** | | | | **Female** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Patient group** | | **Control group** | | **Patient group** | | **Control group** | |
| | **N=10** | **SD** | **N=43** | **SD** | **N=8** | **SD** | **N=32** | **SD** |
| a (mm) | 11.4* | 1.3 | 10.4 | 1.4 | 9.3 | 0.7 | 8.9 | 0.9 |
| b (mm) | 11.5* | 1.3 | 10.4 | 1.4 | 9.3 | 0.7 | 8.9 | 0.9 |
| c (O) | 135.4 | 5.2 | 138.6 | 11.4 | 137.2 | 8.4 | 139.9 | 9.3 |
| d (mm) | 4.2 | 0.6 | 3.6 | 1.0 | 4.0* | 1.1 | 2.9 | 0.8 |
| e (mm) | 8.5 | 2.2 | 7.9 | 1.9 | 7.5 | 1.8 | 7.0 | 1.7 |
| f (mm) | 11.8* | 1.4 | 14.3 | 3.5 | 11.2 | 1.3 | 12.5 | 2.9 |
| g (mm) | 3.4 | 0.8 | 2.8 | 0.9 | 2.6 | 0.5 | 3.2 | 0.8 |

* - these values in the patient group were significantly differing than that of the control group, N - number, SD - standard deviation, a - length of the anterior facet, b - length of the posterior facet, c - angle between anterior and posterior facet, d - depth of the fibular incisura of the tibia, e - vertical distance of tibiofibular overlapping, f - distance between anterior margin of the tibia and anterior margin of the fibula, g - interval between the deeper posterior portion of the fibular incisura of the tibia and the adjacent cortex.

and over of the depth of the FIT). Only one specimen (10%) in man showed a shallow concave of the FIT (below 4 mm of the FIT). Four specimens (50%) in woman showed a significant concave of the FIT, and 4 specimens (50%) in woman showed a shallow concave of the FIT. In the control group, the proportions of significant concave FIT were 54.6% in men and 29.6% in women. In recurrent sprained ankles, the depth of FIT was deeper than the control group. The depth of FIT in man was also deeper than those of the woman in both groups.

**Discussion.** Ankle sprains are common injuries.[9,12,13] In ankle sprains, the incidence of isolated distal tibiofibular syndesmotic ruptures lies between 1-11%.[12,13] If ligamentous injuries associated with ankle fractures are not diagnosed and treated, the patient could develop any of several complications of syndesmotic injury. Tibiofibular diastasis may be the result of widening of the ankle mortise, and in more advanced lesions the fibula might have displaced posteriorly and abducted from the tibia. Steihl[4] observed that anything less than perfect anatomic restoration in syndesmotic injury would lead to early degenerative arthritis. The topic of ankle diastasis associated with fracture has been previously studied and reported.[4,14] Recently, there have been several reports concerning ankle diastasis without fracture.[13,15-17] Many of the literature in orthopedia utilizes the absolute value of 5 mm or less for the distance between the deeper posterior portion of the FIT and the adjacent fibula cortex, any value greater than this should indicate the presence of diastasis.[3-5,18] In this study, the range of distance on MRI was the same in the recurrent sprained ankles and the ankles of control group. It was 2 to 5 mm. There was no difference between the recurrent sprained ankles and the ankles of control group. The length of the facets was measured 11.2 mm in the anterior and 14.89 mm in the posterior on computerized tomography (CT) scan.[5] In the present study, the length of the anterior facet of man and woman in the patient group was 11.4 mm and 9.3 mm and it was 10.4 mm and 8.9 mm in the control group. The length of the posterior facet of man and woman in the patient group was 11.5 mm and 9.3 mm and it was 10.4 mm and 8.9 mm in the control group. The length of the anterior and posterior facets on CT scan was lengthier than our findings. This difference may be depending on the length of facets measured from cadaver on CT scan. We found differences between the patient and control groups; the facets of recurrent sprained ankles were lengthier than those of the control group. We observed that the length of the facets was the same in the anterior and posterior on MRI in both groups. Ebraheim et al[5] reported that the length of the facets was shorter in the anterior than in the posterior in cadaver lower limbs on CT scan. Sclafani[3] and Stiehl[4] expressed that the anterior tubercle is more prominent than the posterior tubercle. In addition, we observed that the length of facets in man was lengthier than those of woman in both groups. In the literature nobody express for gender difference. The depth of FIT is widely variable.[3,5] Ebraheim et al,[5] observed that 60% of the depth of the FIT showed a significant concave, 40% showed a shallow concave. Hocker and Pachucki[19] examined the FIT and reported 75% of the FIT were concave, 16% were convex, 8% were irregular forms. In this study, all of the specimens (the recurrent sprained ankles and the ankles of control group) were concave. In recurrent sprained ankles, 90% of the FIT showed a significant concave (4 mm and over of the depth of the FIT) in men, 50% of the FIT were concave in women. In the control group, the proportions of significant concave FIT were 54.6% in men and 29.6% in women. As seen above, in recurrent sprained ankles, the depth of FIT was deeper than the control group and the depth of FIT in man was also deeper than the woman in both groups. Ebraheim et al[5] found that the depth of the FIT varied from 1.72 mm to 6.78 mm on CT scan. On MRI, we found that the depth of the FIT in both groups varied from 2 mm to 6 mm. Knowing the distance between anterior margin of the tibia and anterior margin of the fibula may be helpful in determining the position of the fibula in the FIT. Ebraheim et al[5] reported that the distance in cadaver study was 17.4 mm. On MRI, in recurrent sprained ankles, it was 11.8 mm for man and 11.2 mm for woman. In the control group, it was 14.3 mm for men and 12.5 mm for women. In the measurement of the distance anterior margin of the tibia and anterior margin of the fibula, it was observed significantly difference in men of the patient and control groups while there was no significantly difference in women of the patient and control groups. In recurrent sprained ankles, fibula was more anterior than in our control group. The measurements of the distance of anterior margin of the tibia and anterior margin of the fibula in both groups were shorter than the measurement of Ebraheim et al[5] study group. This difference may be depending on the difference of population. This distance may also be different according to whether the subject is living or a cadaver. Ebraheim et al[5] observed the relationship between the dimensions of the tibial tubercles and the depth of the FIT, with an angle between anterior and posterior facets increasing, the dimensions of the tibial tubercles decreased and the depth of the FIT became shallow. In the current study, the same relationship was observed in both groups. Moreover, we observed that the dimensions of the tibial tubercles, the depth of the FIT, angle between anterior and posterior facets and the distance between anterior margin of the tibia and anterior margin of the fibula in the patient group differ from the measurements of the control group; in the recurrent sprained ankle, the anterior and posterior tubercles were lengthier, the depth of the fibular incisura of the tibia was deeper and the angle between anterior and posterior facets was smaller from that of the control group. In addition, the fibula was more anterior. We believe that these characteristics which were observed in the recurrent sprained ankles may be anatomically predisposed to the recurrent ankle sprains.

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