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Diagnosis of tibiofibular syndesmosis instability in Weber type B malleolar fractures

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Abstract

Objective: This study was performed to analyze the clinical value of X-ray, computed tomography (CT), and magnetic resonance imaging (MRI) examinations for the diagnosis of distal tibiofibular syndesmosis injuries in Weber type B ankle fractures with reference to the ankle arthroscopic findings.

Methods: This retrospective clinical study involved 52 patients with type B ankle fractures from August 2014 to January 2018. We analyzed the patients' preoperative imaging data and judged the stability of the distal tibiofibular syndesmosis using X-ray, CT, and MRI examinations. We also evaluated the syndesmosis stability with arthroscopy both statically and dynamically.

Results: With the arthroscopic findings as the standard, the sensitivity of X-ray for diagnosing syndesmosis instability was 52.8%, the specificity was 100%, and the diagnostic efficiency was 67.3%. The sensitivity of CT for diagnosing syndesmosis instability was 77.8%, the specificity was 100%, and the diagnostic efficiency was 84.6%. The sensitivity of MRI for diagnosing syndesmosis instability was 100%, the specificity was 81.3%, and the diagnostic efficiency was 94.2%.

Conclusion: This study suggests that an arthroscopic examination may be recommended when the X-ray or CT features are different from the MRI findings while diagnosing tibiofibular syndesmosis instability in Weber type B malleolar fractures.

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Introduction

The distal tibiofibular syndesmosis plays a critical role in maintaining ankle joint stability. In Weber type A and C malleolar fractures, impairment of the syndesmosis is rather clear. In type B malleolar fractures, however, impairment of the syndesmosis is still controversial.[1,2] About half of type B malleolar fractures are reportedly combined with distal tibiofibular syndesmosis injuries.[3] If we define only the bone fracture and ignore the possibility of distal tibiofibular syndesmosis injuries, severe complications such as widening of the ankle mortise, chronic ankle instability, and ankle arthritis may occur in these patients. However, there is no consensus regarding the most effective method of evaluating tibiofibular syndesmosis instability in type B ankle fractures. The most common methods currently used are X-ray examination, computed tomography (CT), and magnetic resonance imaging (MRI).[4–6]

In this study, we directly evaluated the stability of the distal tibiofibular syndesmosis using arthroscopy and compared this technique with the effectiveness of preoperative X-ray, CT, and MRI examinations. The purpose of this study was to retrospectively analyze the clinical value of X-ray, CT, and MRI examinations for the diagnosis of distal tibiofibular syndesmosis injuries in Weber type B ankle fractures with reference to the ankle arthroscopic findings and to screen out the patients who require an arthroscopic examination.

Patients and methods

This retrospective clinical study was approved by our hospital review board. We analyzed patients with ankle fractures treated at our institutions from August 2014 to January 2018. Preoperative X-ray (anteroposterior, lateral, and mortise views), CT (three-dimensional reconstruction), and MRI examinations were routinely performed. The patients' identities are not disclosed in this article. We clearly conveyed the information regarding the arthroscopic examination to each patient during the preoperative conversations, at which time written informed consent was obtained from each patient.

On plain X-ray film examination, the tibiofibular clear space (TFCS) and tibiofibular overlap (TFO) are two parameters commonly used to evaluate the tibiofibular syndesmosis stability. The TFCS is defined as the distance from the posterolateral border of the distal tibia to the medial border of the lateral malleolus at 1 cm above the distal tibial articular surface. The TFO is defined as the distance from the anterolateral margin of the distal tibia to the medial margin of the lateral malleolus (Figure 1).

We also measured the anterior and posterior intervals of the distal tibiofibular syndesmosis on CT sections. The anterior interval of the distal tibiofibular syndesmosis is the distance from the tip of the anterior tibial tubercle to the nearest point of the fibula. Similarly, the posterior interval is the distance

Figure 1. X-ray measurement of the distal tibiofibular syndesmosis. The space labeled "A" is the tibiofibular clear space (distance between posterolateral margin of distal tibia and medial margin of lateral malleolus). The space labeled "B" is the tibiofibular overlap (distance between anterolateral margin of distal tibia and medial margin of lateral malleolus).

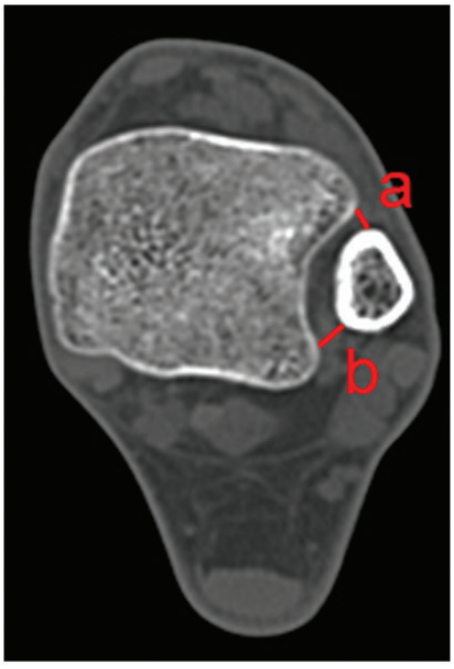

Figure 2. Computed tomography measurement of the distal tibiofibular syndesmosis. The distance labeled "a" is the anterior interval of the distal tibiofibular syndesmosis. The distance labeled "b" is the posterior interval of the distal tibiofibular syndesmosis.

from the medial border of the fibula to the nearest point of the lateral border of the posterior tibial tubercle (Figure 2).

MRI examination can accurately display the synovium of the joint, effusion of the joint, destruction of the articular cartilage, and changes in the periarticular ligaments. Distal tibiofibular syndesmosis injury generally exhibits increased signal intensity of the distal anterior tibiofibular ligament, distal posterior tibiofibular ligament, transverse ligament, and interosseous ligament in T2-weighted imaging and fat-suppressed imaging.[7]

During the operation, arthroscopy was performed in all patients to classify the extent and location of intra-articular damage. The standard anterolateral and anteromedial ankle arthroscopy portals were used. Under arthroscopic examination, we inspected the medial, lateral, or posterior malleolus fracture lines; triangular ligament status; and torn parts of the distal tibiofibular syndesmosis. After bone repositioning, metal plates and hollow screws were used to fix the malleolus fractures, forming a stable framework.

After internal fixation, the Cotton test and the external rotation test were performed while the changes in the syndesmosis joint space were monitored by ankle arthroscopy. The typical fold under the

tibiofibular syndesmosis is white and smooth in arthroscopic views. The tibiofibular syndesmosis is amphiarthrodial, and a 2-mm-diameter arthroscopic probe can be inserted through it. Bleeding and tearing of synovial folds can be seen under ankle arthroscopy in patients with a distal tibiofibular syndesmosis injury. If the syndesmosis exhibits >2-mm diastasis as shown by the Cotton test and external rotation test intraoperatively, a distal tibiofibular syndesmosis injury can be diagnosed (Figure 3). When a syndesmosis injury was confirmed in the present study, a button plate-cable system (TightRope; Arthrex, Naples, FL, USA) was used to stabilize the distal tibiofibular syndesmosis.

The sensitivity, specificity, and diagnostic efficiency of X-ray, CT, and MRI examinations for type B ankle fractures combined with distal tibiofibular syndesmosis injury were compared with the ankle arthroscopic findings. Sensitivity was defined as the proportion of X-ray, CT, or MRI examinations that can diagnose a patient with syndesmosis injury in general. Specificity was defined as the ability to designate a patient who does not have syndesmosis injury in general. Diagnostic efficiency was defined as the number of patients with accurate judgments by X-ray, CT, or MRI examination in general.

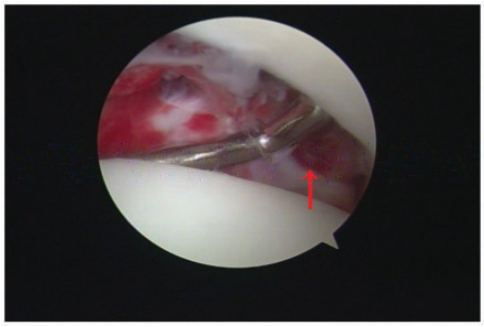

Figure 3. Measurement of the syndesmosis joint space with the arthroscopic probe.

Results

Fifty-eight patients with type B malleolar fractures who were treated with internal fixation and ankle arthroscopy at our institutions from August 2014 to January 2018 were preliminarily included in this study. We then excluded six patients with a history of ankle surgery, ankle deformity, or serious arthritis. The study population thus comprised 52 patients (31 men, 21 women) with type B ankle fractures who had undergone arthroscopic examination along with internal fixation. The patients' mean age was 35.4 ± 11.2 years (range, 18–67 years). Thirty-four patients had sustained the injury on the left side, and 18 had sustained the injury on the right side.

The TFCS and TFO of all patients were measured on the preoperative plain X-ray films. If the TFCS was wider than 5 mm and the TFO was narrower than 10 mm, we considered the presence of tibiofibular syndesmosis instability, which indicated a distal tibiofibular syndesmosis injury. Nineteen patients (36.5%) were diagnosed with tibiofibular syndesmosis injury. Among these patients, the mean TFCS was 8.2 ± 2.5 mm and the mean TFO was 5.9 ± 2.8 mm.

The anterior and posterior intervals of the distal tibiofibular syndesmosis of all patients were measured on the preoperative CT sections. We diagnosed a distal tibiofibular syndesmosis injury when the anterior interval was larger than 2 mm or the posterior interval was larger than 4 mm. In total, 28 patients (53.8%) were diagnosed with a distal tibiofibular syndesmosis injury by CT measurements. In these patients, the mean anterior interval was 3.2 ± 0.7 mm and the mean posterior interval was 5.6 ± 1.1 mm.

On the preoperative MRI examination, we considered a distal tibiofibular syndesmosis injury to have occurred when the ankle demonstrated increased signal intensity within the syndesmotic ligaments. In total, 39 patients (75.0%) were diagnosed

with a distal tibiofibular syndesmosis injury by MRI measurements.

After reduction and fixation of the posterior malleolus, medial malleolus, and lateral malleolus, the Cotton test and the external rotation test were performed while the syndesmosis was observed by arthroscopy. The syndesmosis was judged unstable when the joint space was larger than 2 mm in either one of the two tests. Thirty-six patients were diagnosed with syndesmosis instability by ankle arthroscopy. Hemorrhage and rupture of the synovial tissue inside the syndesmosis joint were the most common signs of syndesmosis injury (Figure 4).

We performed a comprehensive analysis to compare the diagnostic efficiency of X-ray, CT, and MRI examinations with that of arthroscopy for type B ankle fractures combined with distal tibiofibular syndesmosis injury. With the arthroscopic findings as the standard, the sensitivity of X-ray for diagnosing syndesmosis instability was 52.8% (19/36), the specificity was 100% (16/16), the false-positive rate was 0.0% (0/16), the false-negative rate was 47.2% (17/36), and the diagnostic efficiency was 67.3% (19 + 16/52). The sensitivity of CT for diagnosing syndesmosis instability was 77.8% (28/36), the specificity was 100% (16/16), the false-positive rate was 0.0% (0/16), the false-negative rate was 22.2% (8/36), and the diagnostic efficiency was 84.6% (28 + 16/52). The sensitivity of MRI for diagnosing syndesmosis instability was 100% (36/36), the specificity was 81.3% (13/16), the false-positive rate was 18.8% (3/16), the false-negative rate was 0.0% (0/36), and the diagnostic efficiency was 94.2% (36 + 13/52).

Discussion

Based on the arthroscopic findings, we found that X-ray or CT examination can lead to a missed diagnosis in some patients who have distal tibiofibular syndesmosis injury and that MRI can lead to a misdiagnosis of distal tibiofibular syndesmosis injury in some patients who do not have this injury.

Current diagnostic methods for distal tibiofibular syndesmosis injury include preoperative X-ray, CT, MRI, and ankle arthroscopic examinations. The traditional standard for diagnosing tibiofibular syndesmosis injury is measurement of the TFCS and TFO at the level 1 cm above the distal tibial articular surface on X-ray films. If the TFCS is >5 mm and the TFO is <10 mm, a distal tibiofibular syndesmosis injury can be diagnosed.[8] When a distal tibiofibular syndesmosis injury is highly suspected without positive findings on X-ray examination, the Cotton test and the external rotation test are conducted under C-arm X-ray examination to confirm whether an injury is present. The diagnostic criteria are the same as aforementioned. CT has been widely used in the diagnosis of tibiofibular syndesmosis injury and is a more reliable method than X-ray examination.[9–11] Moreover, CT three-dimensional reconstruction can distinguish the injury within 1-mm resolution.[9] In this study, the diagnostic efficiency of CT for type B ankle fracture combined with distal tibiofibular syndesmosis injury was 84.6%, which was higher than that of X-ray fluoroscopy (67.3%). Although this result confirms that CT is more reliable than X-ray examination, it is impossible to examine tibiofibular syndesmosis injuries dynamically.

Injuries of the distal tibiofibular syndesmosis and soft tissues are more clearly seen by MRI than CT.[12,13] Enhanced ligament signal intensity indicates syndesmosis injury in T2-weighted imaging and fat-suppressed imaging. We found that the diagnostic sensitivity of MRI reached 100%, while the false-positive rate was 18.8%. We speculate that this was caused by the interference of tissue fluid exudation

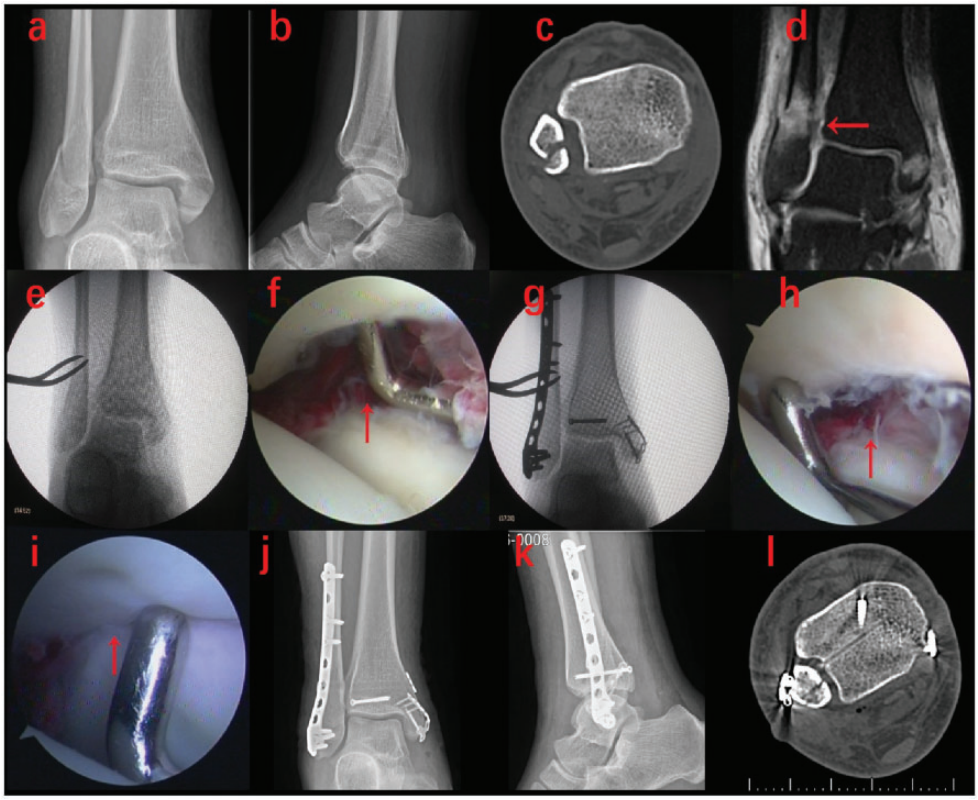

Figure 4. A 41-year-old man who had been injured in a car accident was diagnosed with a type Danis–Weber B ankle fracture and a Lauge–Hansen supination-external rotation ankle injury. Open reduction/internal fixation and ankle arthroscopy were conducted to treat the fractures and distal tibiofibular syndesmosis injury. (a) Preoperative anteroposterior X-ray showed medial and lateral malleolus fractures with displacement. (b) Lateral X-ray showed lateral and posterior malleolus fractures with displacement. (c) Computed tomography scan showed a lateral malleolus fracture, shifting of the fibula from the lateral peroneal notch of the tibia, and a >4-mm posterior interval of the distal tibiofibular syndesmosis. (d) Increased signal intensity of the distal tibiofibular syndesmosis in the coronal plane of T2-weighted magnetic resonance imaging (arrow). (e) The Cotton test showed that the tibiofibular clear space was >5 mm and that the tibiofibular overlap was <10 mm before open reduction. (f) Congested and torn synovial folds were seen under ankle arthroscopy, and the syndesmosis was determined to have >2-mm diastasis (arrow). (g) The Cotton test on X-ray examination showed that the tibiofibular clear space was <5 mm and that the tibiofibular overlap was >10 mm after open reduction and internal fixation, indicating that the distal tibiofibular syndesmosis injury had either been repaired or never existed. (h) Although the width of the distal tibiofibular syndesmosis was shorter than that before internal fixation, the diastasis was still >2 mm (arrow), indicating that the distal tibiofibular syndesmosis injury had not yet been completely repaired. (i) The Cotton test and the external rotation test showed that the distal tibiofibular syndesmosis injury was entirely repaired and that the diastasis was <2 mm under ankle arthroscopy after using a button plate-cable system (TightRope; Arthrex, Naples, FL, USA) (arrow). (j) The anteroposterior X-ray of the ankle joint showed reduction of the medial and lateral malleolus, and the distal tibiofibular syndesmosis was in a good position. (k) The lateral X-ray showed that the lateral and posterior malleolus fractures were well reset and fixed. (l) Computed tomography showed that the lateral malleolus fracture had been reset, the fibula had satisfactory reduction to the lateral fibular notch of the tibia, and the posterior interval of the distal tibiofibular syndesmosis was <4 mm.

after soft tissue injury. Moreover, it is impossible to examine tibiofibular syndesmosis injury dynamically using MRI.

Ankle arthroscopy has many advantages over traditional radiological methods.[14–16] Using arthroscopy, the stability of the distal tibiofibular syndesmosis can be directly evaluated both statically and dynamically. In this study, we found that the distal tibiofibular syndesmosis was unstable as shown by arthroscopic examination when positive findings were present on X-ray or CT examination and that the syndesmosis was static as shown by arthroscopic examination when positive findings were absent on MRI. Therefore, we recommend an arthroscopic examination when the radiographic features differ from the MRI features.

This study has two main limitations. First, it retains the inherent shortcomings of a retrospective study. Second, this was a small single-center study, which also has some inherent shortcomings; therefore, a large multicenter sample study is desired.

In conclusion, this study suggests that an arthroscopic examination may be recommended when the X-ray or CT features differ from the MRI findings in the diagnosis of tibiofibular syndesmosis instability in patients with Weber type B malleolar fractures.

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Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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Supplemental material

Supplemental material is available online.

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