Arthroscopic Diagnosis of Tibiofibular Syndesmosis Disruption

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Purpose: We have been able to diagnose tibiofibular syndesmosis injury by ankle arthroscopy, and in the present study we compare these results with the results from plain radiographs. **Type of Study:** Case series. **Methods:** Thirty-eight type-B (Weber system) distal fibular fractures in 38 patients were diagnosed to determine whether tibiofibular syndesmosis disruption was present. According to the Lauge-Hansen system, 16 patients had supination–external rotation fractures and 22 had pronation-abduction fractures. Standard non–weight-bearing anteroposterior radiographs and mortise radiographs were evaluated. Furthermore, ankle arthroscopy was performed on all patients. **Results:** Tibiofibular syndesmosis disruptions were diagnosed in 16 of the 38 patients (42%) by anteroposterior radiography, 21 of 38 patients (55%) by mortise radiography, and 33 of 38 patients (87%) by ankle arthroscopy. All of the patients who were diagnosed with tibiofibular syndesmosis disruption by anteroposterior radiography and mortise radiography were also confirmed by ankle arthroscopy to have injured their tibiofibular syndesmosis. In 12 patients, ankle arthroscopy was the only method used to diagnose the tibiofibular syndesmosis disruption. **Conclusions:** Ankle arthroscopy excels in term of the diagnosis ratio for tibiofibular syndesmosis disruption compared with both anteroposterior and mortise radiography. Therefore, we conclude that ankle arthroscopy is necessary for the correct diagnosis of tibiofibular syndesmosis disruption. **Key Words:** Ankle—Arthroscopy—Syndesmosis.

The tibiofibular syndesmosis consists of 4 ligaments: the tibiofibular interosseous ligament, the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the transverse tibiofibular ligament.[1] The classifications of Lauge-Hansen[2] attempt to define both the fracture and the ligamentous injury, and tibiofibular syndesmosis disruptions can be accompanied by supination-eversion stages I, II, III, and IV and pronation-abduction stages II and III. Generally, the diagnosis of tibiofibular syndesmosis disruption is based on the radiographic appearance of the affected area, such as that observed by anteroposterior radiography[3] and mortise radiography.[4-6] However, the accuracy of these diagnostic methods has not been defined.

Recently, ankle arthroscopy has become a standard procedure for diagnosing and treating ankle disorders. The diagnostic indications of ankle arthroscopy include unexplained pain, swelling, stiffness, instability, hemarthrosis, locking, and popping. The therapeutic indications include osseous impingement, soft-tissue impingement, arthrofibrosis, fractures, synovitis, loose bodies, osteochondral defects, and osteoarthritis. There is an advantage to ankle arthroscopy in that it is possible to directly visualize the site of the ankle disorder, allowing for correct diagnosis. In this report, we describe the accuracy of diagnosis for tibiofibular syndesmosis disruption using anteroposterior radiography, mortise radiography, and ankle arthroscopy.

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METHODS

Thirty-eight type-B (Weber system) distal fibular fractures in 38 patients were treated by surgery at

Table 1. *Radiographic Measurements and Arthroscopic Findings for the 38 Patients*

Case	Gender, Age at Op (yr)	Fracture Type on Lauge-Hansen System	Anteroposterior Radiograph		Mortise Radiograph			Arthroscopy			
			Syndesmosis A (mm)	Syndesmosis B (mm)	Talocrural Angle (degrees)	Medial Clear Space (mm)	Talar Tilt (mm)	Ant Inf Tibiofibular Ligament	Post Inf Tibiofibular Ligament	Transverse Ligament	Deltoid Ligament
1	M, 18	SE	3	11	85	3	2	CT	N	N	N
2	M, 21	SE	2	12	84	3	1	CT	N	N	N
3	M, 25	SE	4	10	90	7	4	CT	N	PT	N
4	M, 27	SE	7	4	89	6	3	CT	AT	CT	N
5	M, 33	SE	2	11	82	2	1	N	N	N	N
6	M, 35	SE	4	10	88	5	3	CT	N	PT	N
7	M, 42	SE	8	5	88	7	3	CT	AT	AT	N
8	M, 45	SE	7	5	89	8	3	CT	CT	CT	N
9	M, 47	SE	7	6	89	8	3	CT	AT	AT	N
10	M, 48	SE	3	10	82	4	0	PT	N	N	N
11	F, 18	SE	6	7	88	6	1	CT	AT	AT	N
12	F, 26	SE	8	4	89	9	4	CT	AT	CT	N
13	F, 37	SE	2	11	81	3	0	CT	AT	PT	N
14	F, 54	SE	3	12	83	4	0	N	N	N	N
15	F, 55	SE	3	11	83	2	0	N	N	N	N
16	F, 57	SE	3	10	85	3	0	N	N	N	N
17	M, 18	PA	9	4	90	9	3	CT	PT	CT	CT
18	M, 20	PA	6	5	88	7	3	CT	AT	AT	N
19	M, 21	PA	6	8	89	7	3	CT	PT	CT	CT
20	M, 22	PA	4	10	88	6	2	CT	AT	CT	CT
21	M, 24	PA	7	8	88	6	3	CT	AT	AT	N
22	M, 24	PA	6	10	89	6	3	CT	PT	CT	CT
23	M, 27	PA	8	7	88	5	2	CT	AT	CT	CT
24	M, 28	PA	4	10	88	5	3	CT	PT	PT	CT
25	M, 28	PA	2	11	82	2	0	PT	PT	N	N
26	M, 30	PA	3	11	83	3	0	CT	N	N	N
27	M, 33	PA	8	6	89	9	4	CT	PT	CT	CT
28	M, 33	PA	3	10	83	3	0	PT	PT	N	N
29	M, 35	PA	2	10	84	2	1	CT	N	N	N
30	M, 37	PA	2	10	81	2	0	CT	N	N	N
31	M, 43	PA	6	8	86	5	3	CT	AT	CT	CT
32	M, 51	PA	3	11	85	3	1	PT	PT	N	N
33	F, 18	PA	5	9	88	7	3	CT	AT	AT	CT
34	F, 32	PA	6	8	89	5	3	CT	PT	CT	CT
35	F, 39	PA	2	12	82	4	1	PT	N	N	N
36	F, 41	PA	4	10	83	3	0	N	N	N	N
37	F, 42	PA	4	10	88	6	4	CT	N	PT	CT
38	F, 57	PA	3	10	85	3	0	CT	N	N	N

Abbreviations: SE, supination-eversion fractures; PA, pronation-abduction fractures. Syndesmosis A, the tibiofibular clear space from the lateral border of the posterior tibial malleolus to the medial border of the fibula. Syndesmosis B, the overlap from the medial border to the fibula to the lateral border of the anterior tibial prominence. Talocrural angle, angle formed by a line perpendicular to the distal tibial articular surface and a line joining the tips of both malleoli. Medial clear space, the distance from the lateral border of the medial malleolus to the medial border of the talus at the level of the talar dome. Talar tilt, any differences in the widths of the joint space proximal to the medial and lateral talar ridge. CT, complete tear; PT, partial tear; AT, avulsion at the tibial or fibular attachment; N, normal.

Shimane Medical University between March 1996 and April 1999. There were 26 male and 12 female patients, with the mean age at the time of surgery being 40 years (range, 18 to 57 years). Sixteen patients had supination–external rotation fractures, and 22 had pronation-abduction fractures according to the Lauge-Hansen system[2] (Table 1). The distal fibular fractures were treated with a cannulated axial screw in 26 patients and with an antiglide plate in 12 patients. At the time of surgery, we performed ankle arthroscopy and made a diagnosis regarding the presence of tibiofibular syndesmosis disruption. If there was a medial malleolar fracture (Cases 18, 21, 25, 26, 28, 29, 30, 32, 35, and 38), we fixed the fracture site at an anatomically correct position with a cannulated axial screw. If there was a syndesmotic disruption with the deep deltoid ligament disruption seen via ankle arthroscopy (Cases 17, 19, 20, 22, 23, 24, 27, 31, 33, 34, and 37) (Fig 1), the distal tibiofibular joint was stabilized by a syndesmotic screw without the suture of the deltoid ligament. Postoperatively, all patients had their ankles stabilized by a cast for 4 weeks, after which passive range-of-motion exercises of the ankle were performed with soft ankle orthoses. Partial weight bearing was allowed after 4 weeks, and full weight bearing resumed after 6 weeks. Sports activity was allowed 3 months after surgery. At the time of the latest follow-up (a mean follow-up duration of 2 years 7 months; range, 1 to 3.5 years), all patients were examined directly by the first author and evaluated by mean of the West Point Ankle Score system[8] (Table 2). An excellent result was 90 to 100 points, a good

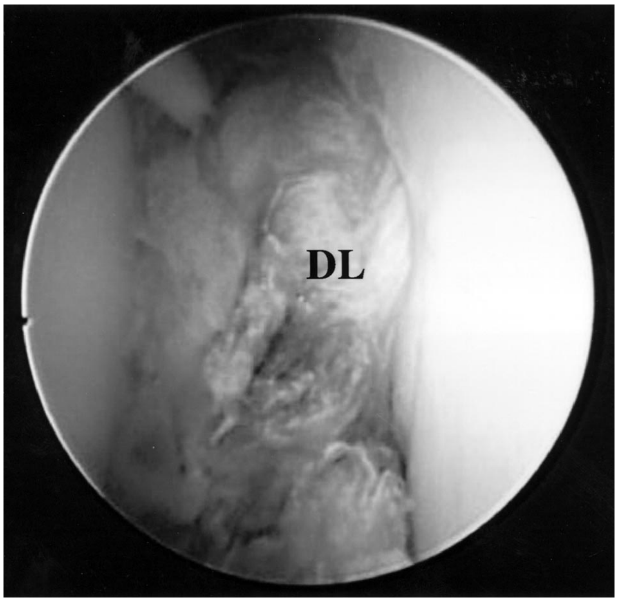

FIGURE 1. Case 23. Arthroscopic findings in the right ankle joint showing the tear of the deltoid ligament (DL). The arthroscope was inserted through the anteromedial portal. The deltoid ligament has a complete tear at the middle of the ligament.

result 80 to 89 points, a fair result 70 to 79 points, and a poor result less than 70 points.

Standard non–weight-bearing anteroposterior radiography and mortise radiography views were evaluated. Anteroposterior radiographs were obtained with the foot in a neutral position. Mortise radiographs were obtained with the leg undergoing 20° of internal rotation. Furthermore, ankle arthroscopy was performed for all patients to provide a diagnosis regarding tibiofibular syndesmosis disruption. Ankle arthroscopy was performed with the patient under spinal lumbar anesthesia. The patient was placed in a supine position on an operating table. The hip was flexed 45° in a leg holder by means of the bandage distraction technique with a force of 78.4 N.[7] The arthroscope was inserted at the anterolateral and anteromedial portals so that the tibiofibular syndesmosis and other structures could be observed. The anterior inferior tibiofibular ligament was best viewed from the anteromedial portal, and the posterior inferior tibiofibular ligament and the transverse tibiofibular ligament were best viewed from the anterolateral portal. In addition, a motorized shaver was inserted at the portal opposite that used by the arthroscope to reject the hematoma and granuloma in order to make it easier to see the tibiofibular syndesmosis.

On the anteroposterior radiographs, we measured the tibiofibular clear space from the lateral border of the posterior tibial malleolus to the medial border of the fibula (syndesmosis A) and the overlap from the medial border of the fibula to the lateral border of the anterior tibial prominence (syndesmosis B)[3] (Fig 2). In agreements with Pettrone et al.,[3] we observed that syndesmosis A is normally less than 5 mm and that syndesmosis B is abnormal if less than 10 mm. In the mortise radiography, we measured the talocrural angle,[6] which is formed by a line perpendicular to the distal tibial articular surface and a line joining the tips of both malleoli, spanning the distance from the lateral border of the medial malleolus to the medial border of the talus at the level of the talar dome (medial clear space)[5] and taking into account any differences in the widths of the joint space proximal to the medial and lateral talar ridge (talar tilt)[4] (Fig 3). In agreement with Sarkisian et al.,[6] Joy et al.,[5] and Ashhurst et al.,[4] we observed that the talocrural angle is normally 83° ± 4°, that a medial clear space greater than 4 mm is abnormal, and that a 2-mm difference in the talar tilt is considered the upper limit of normal.

In the ankle arthroscopy, we examined the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the transverse tibiofibular ligament (Figs 4 and 5). We did not consider the tibiofibular interosseous ligament in this study because it is difficult to examine the proximal portion of this ligament by ankle arthroscopy. We diagnosed each ligament based on criteria that included an assessment of complete tear, partial tear, avulsion at the tibial or fibular attachment, or normal.

The first author carried out the arthroscopic diagnosis. One of the authors carried out the diagnosis based on anteroposterior radiography, and another author carried out the diagnosis based on mortise radiography. Radiographs and ankle arthroscopy were reviewed without knowledge of the patient's history or any other diagnostic results.

RESULTS

The mean West Point Score at the time of the latest follow-up was 95.2 points (range, 87-100), and there were 37 excellent results and 1 good result. All of the patients achieved a full range of motion of the ankle comparable to that of the contralateral side and had resumed their athletic activities at the time of the latest follow-up.

Tibiofibular syndesmosis disruptions were diagnosed in 16 of 38 patients (42%) by anteroposterior radiography, in 21 of 38 patients (55%) by mortise

TABLE 2. *West Point Ankle Score*[8]

Subjective						
Pain	0 Rest-pain w/any walking	1 Pain w/athletic activity	2 Pain limits extreme athletics	3 Mod pain w/extreme exertion	4 Mild pain w/extreme exertion	5 No pain
Instability	0 Instability w/ walking	1 Instability w/ uneven terrain	2 Instability limits athletic activity	3 Mod instability w/ extreme exertion	4 Mild instability w/extreme exertion	5 No instability
Swelling	0 Constant swelling	1 Swelling w/ any walking	2 Swelling limits athletic activity	3 Mod swelling w/ extreme exertion	4 Mild swelling w/ extreme exertion	5 No swelling
Stiffness	0 No motion flat surfaces	1 Stiffness w/ any walking	2 Stiffness limits athletic activity	3 Mod stiffness w/ extreme exertion	4 Mild stiffness w/ extreme exertion	5 No stiffness
Overall Function	0 Unable to perform ADL	1 Poor function w/ADL	2 Function limits athletic activity	3 Function limits extreme athletics moderately	4 Function limits extreme exertion minimally	5 No functional limits
Objective						
Gait	0 Unable to bear weight	1 Unable to toe raise	2 Obvious limp	3 Slight limp	4 Slight limit heel or toe walk	5 Normal gait
Motion	0 $<10°$	1 10°-30°	2 Unable to dorsiflex past neutral	3 Able to dorsiflex past neutral	4 Loss of $>10°$ dorsiflexion	5 Within 10° of normal side
Instability	0 Grossly unstable	1 2 + anterior drawer inversion stress (+)	2 1 + anterior drawer inversion stress (+)	3 1 + anterior drawer inversion stress (−)	4 Trace anterior drawer	5 Equal to normal side
Tenderness	0 Hospital admission	1 Narcotics necessary	2 Severe	3 Moderate	4 Mild	5 None
Swelling	0 Hospital admission	1 Shoe wear impossible	2 Severe	3 Moderate	4 Mild	5 None
Radiographic	0 Ankylosis	5 Severe DJD	10 Mortise widening, marked DJD, joint incongruity	15 Moderate DJD, normal mortise	20 Mild anterior tibiotalar spurring	25 Normal
Functional	12-m single-leg hop for time. Obtain % of time compared w/normal side. 90%-100% = 25 points; 80%-89% = 20 points; 70%-79% = 15 points; 60%-69% = 10 points; $<60\%$ = 0 points					

radiography, and in 33 of 38 patients (87%) by ankle arthroscopy (Table 1). All of the patients who were diagnosed with tibiofibular syndesmosis disruption by anteroposterior radiography and mortise radiography could also be confirmed to have injured their tibiofibular syndesmosis by ankle arthroscopy. There were 4 cases (25%) in which there was no syndesmotic damage in the supination-eversion ankle fractures (cases 5, 14, 15, and 16), and 1 such case (5%) in the pronation-abduction ankle fractures (case 36). Therefore, the accuracy for the diagnosis of the syndesmosis disruptions was 100%

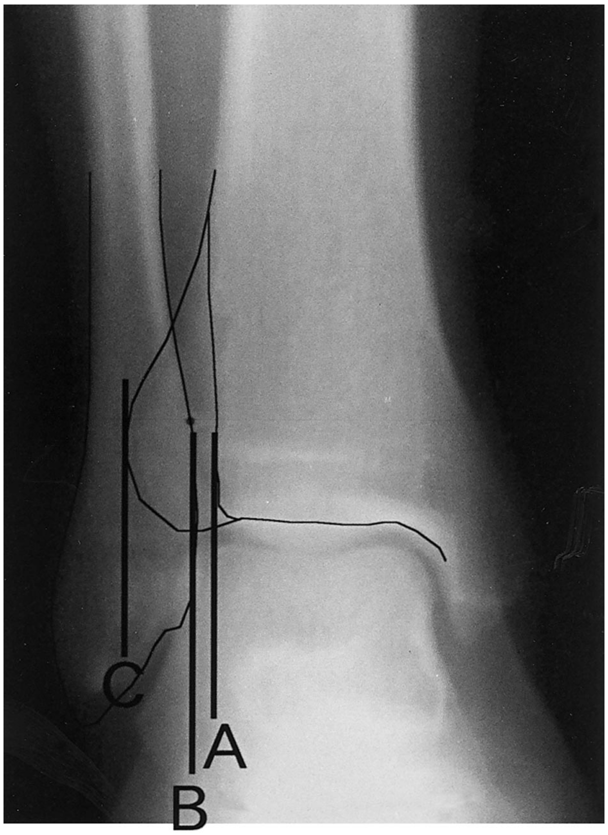

Figure 2. Measurement on anteroposterior radiography of the right ankle. A, lateral border of the posterior tibial malleolus; B, medial border of the fibula; C, lateral border of the anterior tibial tubercle. Syndesmosis A is measured from A to B and syndesmosis B is measured from B to C.

(33 of 33 patients) by ankle arthroscopy compared with the 48% (16 of 33 patients) diagnosed by anteroposterior radiography and 64% (21 of 33 patients) diagnosed by mortise radiography. In 12 patients (cases 1, 2, 10, 13, 25, 26, 28, 29, 30, 32, 35, and 38), ankle arthroscopy was the only method used to diagnose the tibiofibular syndesmosis disruption. In these cases, 4 patients (cases 1, 2, 10, and 13) had no medial malleolus or deltoid ligament disruption, and 8 patients (cases 25, 26, 28, 29, 30, 32, 35, and 38) had medial malleolar fracture with little displacement and no deltoid ligament disruption.

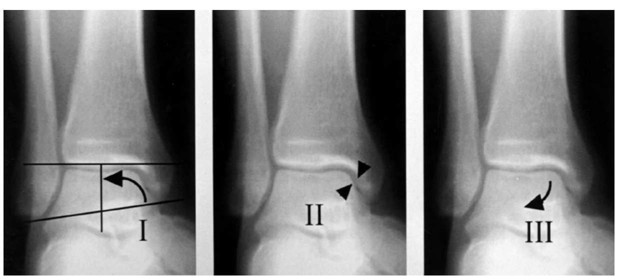

Figure 3. Measurement on mortise radiography of the right ankle. I, talocrural angle; II, medial clear space; III, talar tilt.

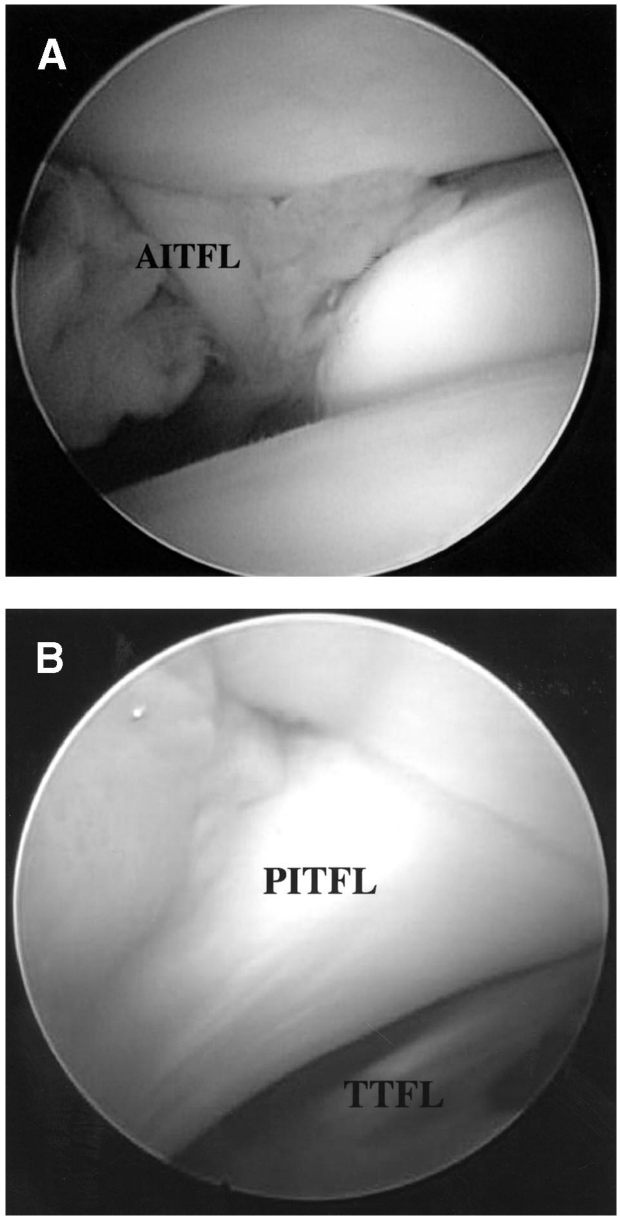

Figure 4. Arthroscopic findings in a normal right ankle joint. (A) Anterior inferior tibiofibular ligament (normal) with the arthroscope inserted through the anteromedial portal. AITFL, anterior inferior tibiofibular ligament. (B) Posterior inferior tibiofibular ligament and transverse tibiofibular ligament (normal) with the arthroscope inserted through the anterolateral portal. PITFL, posterior inferior tibiofibular ligament; TTFL, transverse tibiofibular ligament.

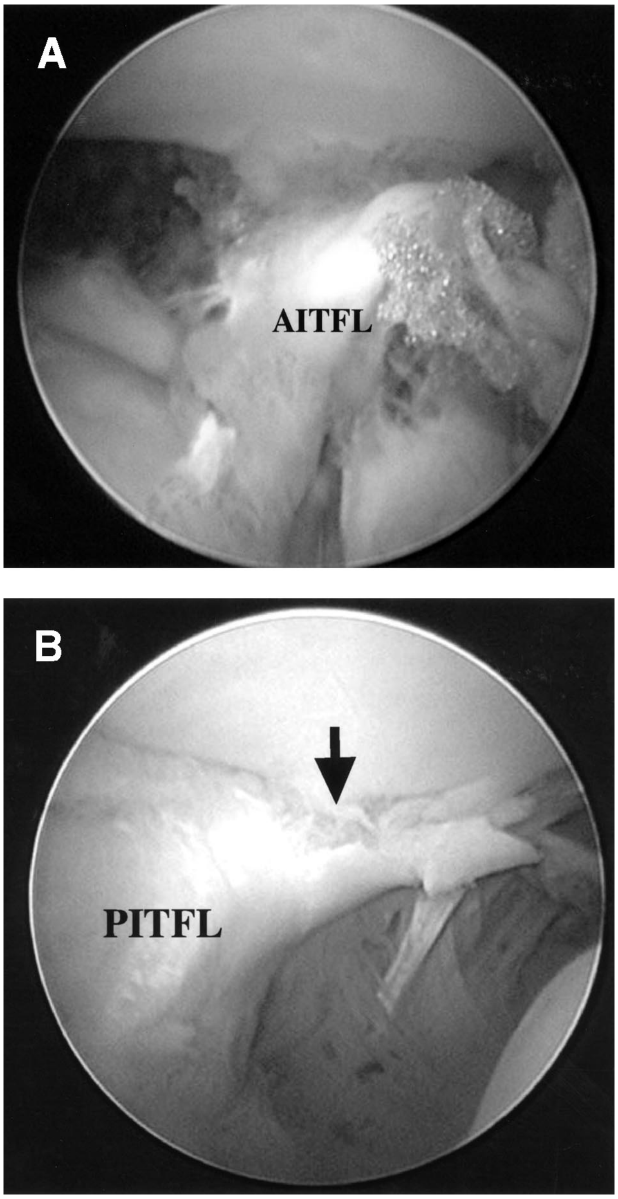

Figure 5. Case 13. Arthroscopic findings in the right ankle joint. (A) Tear of the anterior inferior tibiofibular ligament with the arthroscope inserted through the anteromedial portal. The anterior inferior tibiofibular ligament is torn from the tibial attachment. AITFL, anterior inferior tibiofibular ligament. (B) Tear of the posterior inferior tibiofibular ligament with the arthroscope inserted through the anterolateral portal. The posterior inferior tibiofibular ligament is torn off from the tibial attachment. The arrow indicates the avulsion fracture of the tibial attachment of the posterior inferior tibiofibular ligament. PITFL, posterior inferior tibiofibular ligament.

DISCUSSION

Close[9] and Inman[10] have clarified that normal articular motion in the ankle joint depends on a precise relationship determined by the syndesmosis. The talus normally articulates with the ankle mortise throughout the range of motion, and the intermalleolar distance increases approximately 1.5 mm as the ankle goes from plantar flexion to dorsiflexion. Close[9] reported that, when the deep horizontal section of the deltoid ligament is cut, this diastasis increases to 3.7 mm. Ramsey and Hamilton[11] reported that, when the talus moves laterally by 1 mm, the contact area in the tibiotalar articulation is decreased by 42%. Furthermore, Burns et al.[12] have shown that a complete disruption of syndesmosis with a disruption of the deltoid ligament causes a 40% decrease in the tibiotalar contact area and a 36% increase in the tibiotalar contact pressures. Therefore, a correct diagnosis of tibiofibular syndesmosis disruption is important in the treatment of the injured ankle.

Lauge-Hansen[2] produced low spiral oblique fractures of the fibula in freshly amputated specimens by applying various types of stress. His results suggest that the anterior inferior tibiofibular ligament and posterior inferior tibiofibular ligament are ruptured in supination-eversion injuries, and that the anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, and interosseous tibiofibular ligament are ruptured in pronation-abduction injuries. However, in the present study, the tibiofibular syndesmosis was disrupted in no more than 12 of 16 patients in supination-eversion injuries and 21 of 22 patients in pronation-abduction injuries. Cedell and Wiberg[13] found that the anterior inferior tibiofibular ligament was injured in 380 of 405 ankles in a large series of supination-eversion ankle fractures treated by open reduction. Therefore, the tibiofibular syndesmosis is not always ruptured in those types of ankle fractures.

Radiographic diagnosis is carried out by anteroposterior and mortise radiography. Several authors have reported the measurement of tibiofibular syndesmosis using radiography. In anteroposterior radiography, the tibiofibular clear space from the lateral border of the posterior tibial malleolus to the medial border of the fibula (syndesmosis A) and the overlap from the medial border of the fibula to the lateral border of the anterior tibial prominence (syndesmosis B) were measured.[3] Syndesmosis A is normally less than 5 mm, and syndesmosis B is normally 10 mm or more. In mortise radiography, the clinician measures the talocrural angle,[6] which is formed by a line perpendicular to the distal tibial articular surface and a line joining the tips of both malleoli, spanning the distance from the lateral border of the medial malleolus to the medial border of the talus at the level of the talar dome[5] and taking into account any differences in the widths of the joint spaces proximal to the medial and lateral talar ridge.[4] The talocrural angle is normally 83° ± 4°, the medial clear space is normally less than 3 mm, and 2-mm differences in the talar tilt are considered to be the upper limit of normal. However, it is difficult to diagnose injuries of syndesmotic ligaments by radiographic examination when there is no opening of the distal tibiofibular joint.

Injuries of syndesmotic ligaments are sometimes difficult to diagnose by radiographic examination when the tears are incomplete or if there is no opening of the distal tibiofibular joint. Physical examinations are useful in diagnosing these cases. The physical examinations include the squeeze test[14] and Cotton test.[15] The squeeze test was described in 1990 by Hopkinson et al.[14] and is performed by compressing the fibula to the tibia above the midpoint of the calf. The test is positive when proximal compression produces pain in the area of tibiofibular syndesmosis. The Cotton test was described in 1910 by Cotton[15] and involves stabilizing the distal lower leg with one hand and grasping each side of the foot at the talus with the thumb and forefinger of the other hand. By applying a mediolateral force, crepitus and instability can be assessed from the mortise widening. These are excellent procedures for diagnosing tibiofibular syndesmosis disruption at an early stage. However, it is difficult to carry out these examinations in distal fibular fractures because of ankle pain.

In 1931, Burman[16] reported that the ankle joint was not suitable for arthroscopy because the joint space was too narrow for even a very thin needle to be inserted. With the progress of optical technology, the diameter of the arthroscope has been minimized. Since Watanabe[17] developed the Selfoc arthroscope in 1972, ankle arthroscopy has become a standard procedure in the diagnosis and treatment of disorders of the ankle. The diagnostic indications include unexplained pain, swelling, stiffness, instability, hemarthrosis, locking, and popping. The therapeutic indications include osseous impingement, soft-tissue impingement, arthrofibrosis, fractures, synovitis, loose bodies, osteochondral defects, and osteoarthritis. With the direct visualization made possible by ankle arthroscopy, it is possible to more accurately diagnose intra-articular disorders. Ogilvie-Harris et al.[18] have reported that arthroscopic evaluation is extremely helpful for tibiofibular syndesmosis disorders. In the present study, tibiofibular syndesmosis disorders were diagnosed in 33 of 33 patients (100%) by ankle arthroscopy compared with the 16 of 33 patients (48%) diagnosed by anteroposterior radiography and 21 of 33 patients (64%) diagnosed by mortise radiography. In addition, the tibiofibular syndesmosis disruption identified by anteroposterior radiography and mortise radiography could also be confirmed by ankle arthroscopy.

Close[9] reported that, when the deep horizontal section of the deltoid ligament is cut, the widening of tibiofibular diastasis increases to 3.7 mm. In the present study, syndesmotic disruptions could not be diagnosed in 12 patients by anteroposterior and mortise radiographs because of the small amount of widening of the tibiofibular diastasis, and ankle arthroscopy was the only method that allowed the diagnosis of tibiofibular syndesmosis disruption. In these cases, 4 patients had no medial malleolus or deltoid ligament disruption, and 8 patients had medial malleolar fracture with little displacement and no deltoid ligament disruption. Therefore, we decided that if there was no deltoid ligament disruption, there may be little widening of tibiofibular diastasis and it may be difficult to diagnose tibiofibular syndesmosis disruption by plain radiography.

In conclusion, tibiofibular syndesmosis disruption was frequently accompanied by distal fibular fractures. In the present study, we clarified the accuracy of the diagnosis of syndesmosis disruptions by diagnosing 100% of the cases by ankle arthroscopy compared with 48% diagnosed by anteroposterior radiography and 64% diagnosed by mortise radiography. We conclude that ankle arthroscopy is necessary for the correct diagnosis of tibiofibular syndesmosis disruption.

REFERENCES

1. Grath GB. Widening of the ankle mortise: A clinical and experimental study. *Acta Chir Scand* 1960;263:1-88 (suppl).
2. Lauge-Hansen N. Fracture of the ankle: II. Combined experimental-surgical and experimental-roentgenologic investigations. *Arch Surg* 1950;60:957-985.
3. Pettrone FA, Gail M, Pee D, Fitzpatrick T, Van Herpe LB. Quantitative criteria for prediction of the results after displaced fracture of the ankle. *J Bone Joint Surg Am* 1983;65:66-77.
4. Ashhurst APC, Bromer RS. Classification and mechanism of fractures of the leg bones involving the ankle: Based on a study of three hundred cases from the Episcopal Hospital. *Arch Surg* 1922;4:51-129.
5. Joy G, Patzakis MJ, Harvey JP. Precise evaluation of the reduction of severe ankle fractures: Technique and correlation with end results. *J Bone Joint Surg Am* 1974;56:979-993.
6. Sarkisian JS, Cody GW. Closed treatment of ankle fractures: A new criteria for evaluation—A review of 250 cases. *J Trauma* 1976;16:323-326.
7. Takao M, Ochi M, Shu N, Naito K, Matsusaki M, Tobita M, Kawasaki K. Bandage distraction technique for ankle arthroscopy. *Foot Ankle* 1999;20:389-391.

8. DeBerardino TM, Arciero RA, Taylor DC. Arthroscopic treatment of soft-tissue impingement of the ankle in athletes. *Arthroscopy* 1997;13:492-498.
9. Close JR. Some applications of the functional anatomy of the ankle joint. *J Bone Joint Surg Am* 1956;38:761-781.
10. Inman VT. *The joint of the ankle*. Baltimore: Williams & Wilkins, 1976.
11. Ramsey PL, Hamilton W. Changes in tibiotalar area of contact caused by lateral talar shift. *J Bone Joint Surg Am* 1976;58: 356-357.
12. Burns WC II, Prakash K, Adelaar R, Beaudoin A, Krause W. Tibiotalar joint dynamics: indications for the syndesmotic screw—A cadaver study. *Foot Ankle* 1993;14:153-158.
13. Cedell CA, Wiberg G. Treatment of eversion-supination fracture of the ankle (2nd degree). *Acta Chir Scand* 1962;124:41-44.
14. Hopkinson WJ, St. Pierre P, Ryan JB, Wheeler JH. Syndesmosis sprains of the ankle. *Foot Ankle* 1990;10:325-330.
15. Cotton FJ. *Fractures and joint-dislocations*. Philadelphia: WB Saunders, 1910;549.
16. Burman MS. Arthroscopy of direct visualization of joint: An experimental cadaver study. *J Bone and Joint Surg* 1931;13: 669-695.
17. Watanabe M. Arthroscope. Present and future. *Surg Ther* 1972;26:73-77.
18. Ogilvie-Harris DJ, Reed SC. Disruption of the ankle syndesmosis: Diagnosis and treatment by arthroscopic surgery. *Arthroscopy* 1994;10:561-568.