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EDITORIAL

Diagnosing syndesmotic instability in ankle fractures

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Abstract

The precise diagnosis of distal tibiofibular syndesmotic ligament injury is challenging and a distinction should be made between syndesmotic ligament disruption and real syndesmotic instability. This article summarizes the available evidence in the light of the author's opinion. Pre-operative radiographic assessment, standard radiographs, computed tomography scanning and magnetic resonance imaging are of limited value in detecting syndesmotic instability in acute ankle fractures but can be helpful in planning. Intra-operative stress testing, in the sagittal, coronal or exorotation direction, is more reliable in the diagnosis of syndesmotic instability of rotational ankle fractures. The Hook or Cotton test is more reliable than the exorotation stress test. The lateral view is more reliable than the AP mortise view because of the larger displacement in this direction. When the Hook test is used the force should be applied in the sagittal direction. A force of 100 N applied to the fibula seems to be appropriate. In the case of an unstable joint requiring syndesmotic stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test. When the surgeon is able to perform an ankle arthroscopy this technique is useful to detect syndesmotic injury and can guide anatomic reduction of the syndesmosis. Many guidelines formulated in this article are based on biomechanical and cadaveric studies and clinical correlation has to be established.

Key words: Ankle fracture; Syndesmosis; Ligament; Instability; Operative treatment; Stabilisation

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INTRODUCTION

A syndesmosis is a fibrous articulation in which the opposing joint surfaces are united by ligaments[1]. The distal tibiofibular syndesmosis consists of a complex of ligaments that provides stability to this joint. The anterior and posterior tibiofibular ligaments together with the interosseous ligament form the syndesmosis. The inferior transverse tibiofibular ligament is sometimes considered a fourth ligament but is rather a continuation of the posterior tibiofibular ligament[2].

Syndesmotic injuries are most commonly associated

with Weber C/pronation external rotation or pronation abduction[3] and less frequently with Weber B/supination external rotation (SER)[4] ankle fractures. Syndesmotic injury can also occur in isolation mostly due to an exorotation trauma or in association with damage to the lateral ankle ligaments after traumatic supination[5,6]. There could be subsequent mortise instability and this should be treated with syndesmotic stabilisation to prevent long-term complications of syndesmotic diastasis. Ramsey *et al*[7] reported that, when the talus moves 1mm laterally, the contact area in the tibiotalar articulation is decreased by 42%. 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[8]. Immediate reconstruction of the unstable syndesmosis is indicated, because a delay could expedite the development of degenerative arthritis.

To date, the need for distal tibiofibular syndesmotic fixation is not fully clear despite the abundance of literature concerning the treatment of ankle fractures and isolated syndesmotic injuries[9]. The syndesmotic screw or other stabilising techniques are all effective in stabilising the distal tibiofibular syndesmosis to allow ligamentous healing or to allow a fibrous union[10]. Despite the numerous biomechanical and clinical studies concerning ankle fractures, there are no consistent recommendations regarding the technical aspects of placement in syndesmotic screw fixation[11].

The placement of a syndesmotic screw may require an additional operation for removal of the screw and both operations are not without complications. Late repairs are satisfactory but result in less favorable outcomes than properly treated acute injuries[12]. It is not easy to regain complete stability by means of these secondary procedures[12]. Because of these conflicting factors it is important to clearly identify the patients who will require (temporary) distal tibiofibular syndesmotic stabilisation. The precise diagnosis of syndesmosis disruption is challenging and a distinction should be made between syndesmotic ligament disruption and real syndesmotic instability. History and physical examination are not completely reliable indicators because of symptoms due to the ankle fracture itself.

PRE-OPERATIVE ASSESSMENT

Radiographic measurements such as tibiofibular overlap, tibiofibular clear space, medial and superior clear space are of little value in detecting syndesmotic injury[13,14], probably because all these parameters depend on the rotation of the ankle[13,15]. Even additional quantitative measurement of all syndesmotic parameters with repeated radiographs of the ankle can only be used only as a guide in the diagnosis and management of syndesmotic injuries and not solely relied upon for treatment decisions[13,14].

Although Maisonneuve ankle fractures always require syndesmotic stabilisation[16], there is no correlation between the level of the fibula fracture and the need for syndesmotic stabilisation[17-19]. This is possibly because the level of the fibular fracture does not correlate reliably with the integrity or extent of the interosseous membrane tears and the status of the strongest posterior syndesmotic ligament in operative ankle fractures[14].

Based on a cadaver study, Boden *et al*[20] proposed that syndesmotic fixation is unnecessary if rigid medial malleolar fixation can be achieved or, in the case of deltoid disruption, the fibular fracture is 3 to 4.5 cm proximal to the ankle joint. Recently we observed that the Boden criteria may be helpful in planning, but may have some limitations as a predictor of syndesmotic instability in distal pronation-external rotation ankle fractures[19].

Even the Lauge-Hansen classification is not able to predict syndesmotic instability. This system can be used only as a guide in the diagnosis and management of ankle fractures and not solely relied upon for decisions on treatments such as syndesmotic stabilisation[21].

Computed tomography scanning[22], ultrasound[23] and magnetic resonance imaging (MRI)[24,25] could be valuable in detecting syndesmotic disruption in patients with chronic or isolated syndesmotic injuries but their usefulness in predicting instability in acute ankle fractures is not proven. Vogl *et al*[26] and Oae *et al*[27] concluded that magnetic resonance imaging of the syndesmotic complex is a highly sensitive and specific tool for the evaluation of syndesmotic injury[26] and even syndesmotic disruption[27].

MRI does not provide a dynamic assessment of the distal tibiofibular syndesmosis, so although a rupture of one or more of the ligaments can be identified, instability cannot be diagnosed but only suspected with a MRI scan. Another disadvantage is that he MRI is expensive and often not readily and rapidly available[28].

Pre-operative assessment is less valuable in detecting syndesmotic instability in acute ankle fractures but can be helpful in planning.

INTRA-OPERATIVE ASSESSMENT

Jenkinson *et al*[29] concluded that fluoroscopic stress examination of rotational ankle fractures significantly increases the rate of detection of syndesmotic instability when compared to preoperative evaluation based on standard radiography and biomechanical criteria.

The external rotation test used as a manual stress or a gravity stress test is widely recognized as a clinical tool for the diagnosis of deltoid ligament incompetence in SER ankle fractures[30]. The role of stress radiography in

Table 1 Arthroscopic assessment of distal tibiofibular syndesmotic stability

Study, yr	Patients	Test
Takao *et al*[39], 2001	38 Weber B fractures, 26 males, 40 yr	Arthroscopic anatomical examination of anterior tibiofibular ligament, the posterior tibiofibular ligament, and the transverse tibiofibular ligament. The interosseous ligament and membrane were not assessed Syndesmotic disruptions were diagnosed in 16 of 38 patients (42%) by AP radiography, in 21 of 38 patients (55%) by mortise radiography, and in 33 of 38 patients (87%) by ankle arthroscopy
Sri-Ram *et al*[37], 2005	1 Maisonneuve ankle fracture, image intensifier showed no syndesmotic diastasis	> 2 mm movement in between the tibia and fibula during arthroscopy
Lui *et al*[38], 2005	53 Weber B and C fractures, 35 yr, without radiographic evidence of frank syndesmosis diastasis	⩾ 2 mm displacement of lateral malleolus in coronal or sagittal plane. Displacement of anterior border of the lateral malleolus at least 2 mm more than displacement of the posterior border of the lateral malleolus 16 cases had positive intraoperative stress radiographs; 35 cases had positive arthroscopic findings of syndesmosis diastasis, including various combinations of coronal, sagittal, and rotational planes of instability
Ono *et al*[40], 2004	105 ankle fractures, 59 males, 46 yr	Distal tibiofibular joint instability was detected by a squeeze test under fluoroscopy or by residual, arthroscopically observed diastasis of the joint Persistent instability of the distal tibiofibular joint, which was detected under fluoroscopy and arthroscopy in 8 patients
Takao *et al*[36], 2003	52 acute ankle injuries, 31 males, 35 yr	Arthroscopic anatomical assessment of AITFL and the PITFL, transverse ligament, interosseous ligament and membrane were not assessed The accuracy of AP radiography, mortise radiography and MRI was compared with arthroscopy for the diagnosis of a tear of the tibiofibular syndesmosis
Hintermann *et al*[41], 2002	148 chronic ankle instabilities, 38 males, 34 yr	Arthroscopic anatomical assessment of AITFL, PITFL, and the transverse ligament

the diagnosis of distal tibiofibular syndesmotic instability is less clear[28], although recent data have suggested that many surgeons (69%) use the intra-operative lateral stress test to assess syndesmotic stability[31].

The absence of distal tibiofibular diastasis on static radiographs is not sufficient to exclude syndesmotic instability in patients with ankle injuries.

Intra-operative stress testing, in sagittal, coronal or exorotation direction, is essential in the diagnosis and treatment of rotational ankle fractures.

Which test?

On the basis of a biomechanical cadaveric study, Stoffel *et al*[28] concluded that use of the lateral (bone hook) stress test or Cotton test[32] and examination of the tibiofibular clear space on stress radiographs intra-operatively is more reliable, because of the greater displacement when performing this test, than the exorotation stress test.

The "Hook" or "Cotton" test is more reliable than the exorotation stress test.

Which direction?

Several authors[28,33,34] have concluded that assessment of sagittal plane movement appears to be a more sensitive test of inferior tibiofibular instability than assessment of movement in coronal plane[33]. Coronal plane instability as observed on an AP mortise view only occurs where the deltoid ligament or the whole interosseous membrane is also divided[33]. Candal-Couto *et al*[33] used the Hook test in both directions and Xenos *et al*[34] used the exorotation test.

The lateral view is more reliable that the AP mortise view because of the greater displacement in this direction. When the Hook test is used the force should be applied in the sagittal direction.

How much force?

Most studies do not report the level or type of force used in tests to detect syndesmotic instability[28]. Boden *et al*[20] used a combined pronation-external rotation force of 440 N, whereas Stoffel *et al*[28] used an external rotation load of 150 N resulting in an external moment of 7.5 Nm. The tibiofibular clear space is relatively independent of external rotation force and there may be no benefit in using an external rotation moment of more than 7.5 Nm[28]. In this study a lateral force of 100 N was applied to the ankle mortise and forces of > 100 N did not show any substantial increase in displacement[28].

Based on these data, application of a force of 100 N seems appropriate.

How much displacement?

Currently available literature does not provide clear guidelines for the amount of displacement or degree of diastasis required for performing syndesmotic stabilisation.

Jenkinson *et al*[29] used a 1-mm increase in tibiofibular clear space on an external rotation stress radiograph as an indication for syndesmotic stabilisation. However,

this may probably lead to overtreatment of many ankle fractures[28]. Leeds *et al*[35] suggested 2 mm as an unacceptable increase in the tibiofibular clear space. In addition, Stoffel *et al*[28] showed that syndesmotic injuries correlate with relatively small increases in the measurements on stress radiographs. The ability of the surgeon to manually detect these small increases in intra-operative tibiofibular clear space has been questioned[29].

Stoffel *et al*[28] formulated guidelines for clinical practice. The superior clear space in a normal ankle joint is approximately 3 to 4 mm, which is also the maximum tibiofibular clear space value indicating a stable ankle joint. In the case of an unstable joint requiring syndesmotic stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test[28].

Clinical studies are now required to determine the acceptable degree of displacement of the distal tibiofibular syndesmosis after ankle fracture fixation. In the case of an unstable distal tibiofibular syndesmosis requiring stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test.

ARTHROSCOPY

Recent publications[36-41] (Table 1) state that ankle arthroscopy is a more sensitive method than intraoperative stress radiography[36-38]. Moreover, ankle arthroscopy can aid analysis of different patterns of syndesmosis diastasis and also guide anatomic reduction of the syndesmosis[37]. However, there are some limitations of these studies as it is not known how much diastasis the syndesmosis allows and whether the physiologic laxity is similar in the anterior and posterior part of the syndesmosis. It is known that the distance between the tibia and fibula is variable over the joint line. The central part contains the tibiofibular syndesmotic recess whose dimensions are not known. I agree with Takao *et al*[36,39] that arthroscopy is very valuable for the accurate diagnosis of a tear of the tibiofibular syndesmosis. However, the observation of a ruptured anterior syndesmotic ligament during arthroscopy does not mean that there is syndesmotic instability because the interosseous ligament and the interosseous membrane cannot reliably be assessed during ankle arthroscopy. In most SER IV ankle fractures the anterior and posterior syndesmotic ligaments are ruptured but syndesmotic instability is rare[42]. Ankle arthroscopy is useful for identifying ruptures of the syndesmotic ligaments intraoperative, although the test is more invasive and not all surgeons have the expertise to perform an ankle arthroscopy.

The advantage of this technique is that it provides assessment of different planes of instability and assists anatomic reduction of the syndesmosis. Syndesmotic stabilisation without direct visualization has a high percentage of malreduction[43]. Even surgeons with arthroscopic experience state that intraoperative radiography still plays an important role in assessing fracture reduction as well as proper restoration of fibular length and longitudinal orientation of the syndesmosis[38]. Future research is required into the amount of displacement of the fibula in relation to the tibia, necessary to detect syndesmotic instability. When the surgeon is able to perform an ankle arthroscopy this technique is useful to detect syndesmotic injury and guide anatomic reduction of the syndesmosis.

DISCUSSION

General radiographic criteria for syndesmotic fixation are of low value compared with the intraoperative impression of the syndesmotic stability in all operated ankles. Preoperative planning is essential but not sufficient to determine the necessity for syndesmotic fixation. The pre-operative assessments can be used only as a guide in the diagnosis and management of syndesmotic instability associated with ankle fractures and cannot be solely relied on for treatment of these injuries. Other factors influencing the choice of fixation include the presence of posterior malleolus fractures, deltoid ligament injuries, and subluxation of the fibula[2,44]. The decision to stabilize the distal tibiofibular syndesmosis should be made based on intra-operative (stress testing of arthroscopic] findings.

There is a lack of published information, particularly in relation to the performance of intra-operative stress testing of syndesmotic stability. So far, there are no clear answers to the questions: which test?, which direction?, how much force?, how much displacement ? Many of the guidelines outlined in this article are based on biomechanical and cadaveric studies and clinical correlation has to be established.

Whenever the surgeon is in doubt about syndesmotic instability, I believe stabilisation of the distal tibiofibular joint should be performed because of the problems caused by chronic syndesmotic instability[9,12].

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