RESEARCH ARTICLE

Syndesmotic Malreduction after Ankle ORIF; Is Radiography Sufficient?

Alireza Manafi Rasi, MD; Gholamhossein Kazemian, MD; Mohamad M Omidian, MD; Ali Nemati, MD

Research performed at Department of Orthopedic Surgery, Imam Hosein Hospital, Shahid Beheshti University of Medical Sciences, Tehran,Iran

Received: 16 July 2013 *Accepted: 14 December 2013*

Abstract

Background: Ankle fractures, especially those resulting from external rotation mechanisms are associated with injury to the distal tibiofibular syndesmosis. Some authors have recommended performing CT scanning after open ankle surgery to evaluate the reduction of syndesmosis. In this current study, we aimed to investigate the sensitivity of plain radiography in diagnosing syndesmosis malreduction after open reduction and internal fixation (ORIF) in patients with ankle fractures.

Methods: Thirty patients with ankle fractures participated in this prospective study. ORIFs were performed with respect to all of the technical guidelines shown in orthopedic literature for exact syndesmosis reduction, such as fibular length and proper settings. In the operating room, plain radiography was performed in anteroposterior, mortise and lateral views to assess whether syndesmosis was malreduced. If malreduction was detected, the patient was revised. As the gold standard, patients underwent postoperative bilateral CT scanning to investigate the syndesmosis reduction which was then compared to the healthy side. Finally, the sensitivity of plain radiography in the diagnosis of syndesmosis malreduction was determined by comparing this method to CT scanning.

Results: In both of the methods we did not find any patient with syndesmosis malreduction. Hence, the sensitivity of plain radiography was determined 100%.

Conclusion: Based on our findings, there is no need to perform CT scanning to evaluate syndesmosis reduction after ankle ORIF in patients with ankle fractures. Plain radiography is sufficient and has satisfactory sensitivity in these patients.

Keywords: Ankle fracture, CT scanning, Plain radiography, Syndesmosis

Introduction

Tibiofibular syndesmosis is an anatomical term that describes the connection between the distal tibia and the fibula which forms ankle mortise (1). This structure is composed of four ligaments including the anterior tibiofibular ligament (AITFL), the posterior inferior tibiofibular ligament (PITFL), the transverse tibiofibular ligament, and the interosseous tibiofibular ligament (2). Ankle fractures, one of the most common orthopedic injuries, can be associated with syndesmosis injury and diastasis, especially when resulting from an external rotation mechanism (3-8). It is reported that syndesmosis injury occurs in more than 13% of patients with ankle fracture and in 20% of patients requiring internal fixation (2, 9-11). Injury to the syndesmosis results in severe ankle instability and requires long-term treatment (12, 13). There is consensus that anatomical reduction of ankle fractures and preservation of the stability and congruity of the mortise is an important prerequisite for achieving good long-term results and can decrease the incidence of posttraumatic osteoarthritis, but the appropriate method for evaluating syndesmosis stability in ankle fractures remains controversial (1, 14-22).

There are several methods used to evaluate the syndesmosis stability including plain radiography, magnetic resonance imaging (MRI), CT scanning and arthroscopy (4-6, 13). HR Chissell *et al* believed that CT imaging is more sensitive than radiography in the diagnosis of syndesmosis injuries; however, diagnosing a very small (1 mm) diastasis is difficult using this method (22).

Based on the necessity of ankle anatomical reduction in patient function and prevention of late complications, it is obvious that we need to find an accurate method to assess the quality of syndesmosis reduction after ankle surgeries. Some believe that plain radiography is not a sensitive and accurate method for the diagnosis of syndesmosis injuries and orthopedic literature suggests that postoperative CT scanning is useful to assess mortise reduction (5,

Corresponding Author: Gholamhossein Kazemian, Department of Orthopedic Surgery, Imam Hossein Hospital, Shahid Madani St, Tehran, Iran.
Email: Ali_nemati802002@yahoo.com

THE ONLINE VERSION OF THIS ARTICLE
ABJS.MUMS.AC.IR

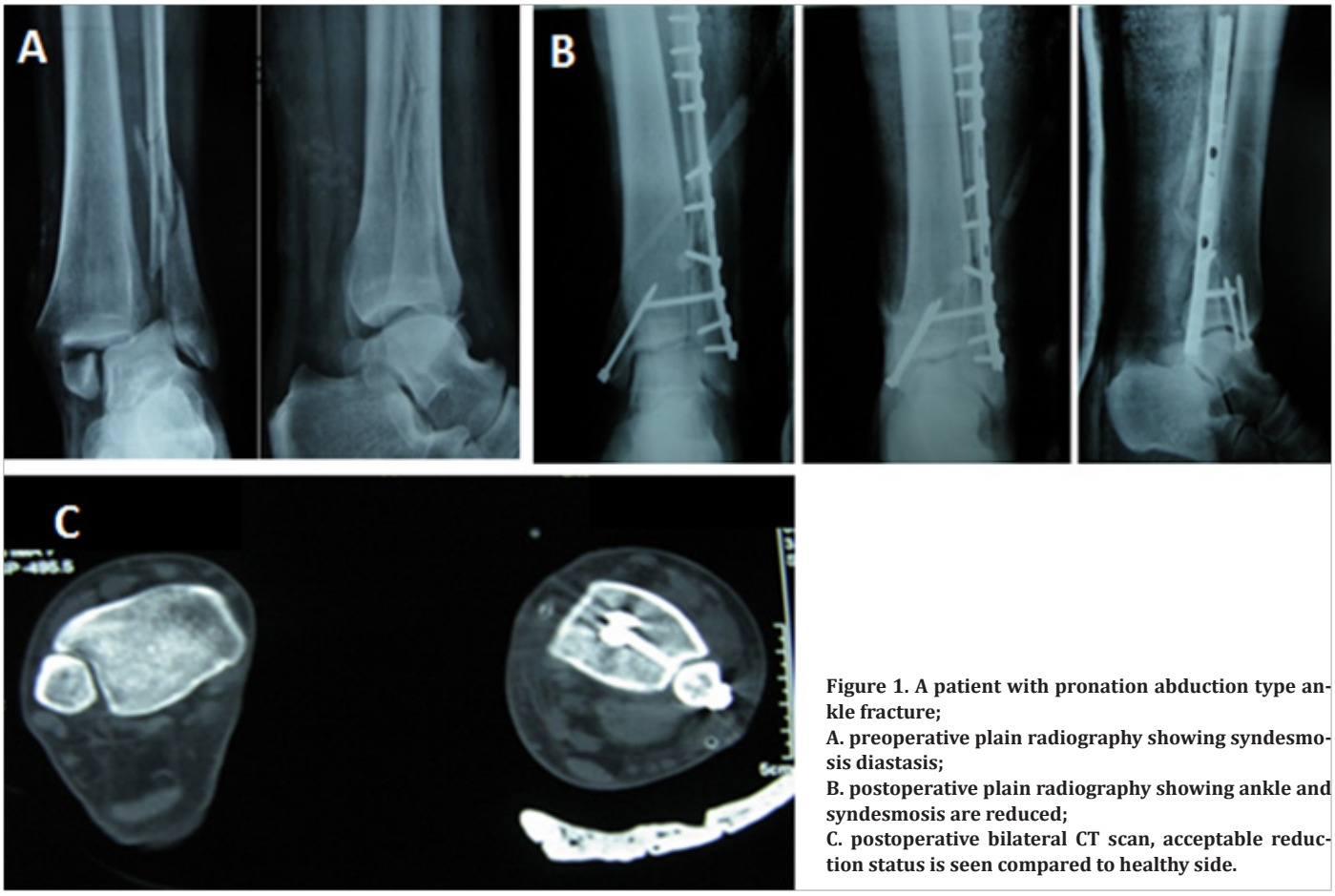

Figure 1. A patient with pronation abduction type ankle fracture;
A. preoperative plain radiography showing syndesmosis diastasis;
B. postoperative plain radiography showing ankle and syndesmosis are reduced;
C. postoperative bilateral CT scan, acceptable reduction status is seen compared to healthy side.

23, 24). However, plain radiography is inexpensive, rapid and available and most of the previous studies have investigated the adequacy of plain radiography in diagnosis of syndesmosis injuries preoperatively. To our knowledge, only one study has evaluated the adequacy of standard postoperative radiographic measurements in syndesmosis reduction compared to CT scanning (23). In this current study we have aimed to investigate the diagnostic value of plain radiography in diagnosing postoperative syndesmosis malreduction in patients with ankle fracture and syndesmosis diastasis compared to CT scanning.

Materials and Methods

In this prospective study, inclusion criteria are patients with closed ankle fractures diagnosed by a physical examination (squeeze test and external rotation stress test) and plain radiography in the anteroposterior (AP), lateral and mortise, who were older than 18 and needed open reduction and internal fixation (ORIF). Before the study, patients signed informed consent forms. Radiographic criteria for the diagnosis of syndesmosis disruption were: the tibiofibular clear space >5 mm and tibiofibular overlap <10 mm in the AP view; tibiofibular overlap <10 mm in the mortise view; and posterior or anterior subluxation in the lateral view. The AP radiograph was taken when the leg was in neutral rotation and the foot was plantigrade. The x-ray beam was placed anterior to the ankle. For the mortise view, the technique was similar to the AP view except that the leg position was in 15° internal rotation. However, the definite syndesmosis disruption was determined based on intraoperative examinations such as the Cotton test. If the patient required syndesmosis reduction, a cortical screw was placed 1.5-2 cm distance from the joint line. The screw was placed parallel to the joint line.

Immediately after surgery, the syndesmosis reduction was assessed in the operating room by plain radiography in the AP, lateral and mortise views and if malreduction was detected, the cortical syndesmosis screw was removed and it was again reduced. If, based on the radiographic parameters, syndesmosis reduction was acceptable, patient was taken out of the operating room and bilateral ankle CT scanning was performed within the first postoperative day. In this study, based on the findings of Dikos *et al*, we used CT imaging of the healthy side to judge the quality of syndesmosis reduction on the operated side (25). Lastly, the presence of incoherency between the findings of CT scanning and plain radiography was investigated and the adequacy of postoperative plain radiography in the diagnosis of syndesmosis malreduction was determined by comparing it to CT scanning.

Results

Thirty (30) patients enrolled in this study and the mean age was 26.7±5.5 years (range: 20-37 years). Of them, 22 patients were male (73.3%) and eight patients were female (26.7%). Ankle fractures were the result of direct trauma in 25 patients (83.3%) and ankle sprain in five patients (16.7%). Based on the Lauge-Hansen classification,

there were six (20%), 15 (50%) and nine (30%) fractures that resulted from supination-external rotation, pronation-external rotation and pronation-abduction mechanisms, respectively. There was no patient with supination-adduction fracture in our study.

After the operation, we found that adequate syndesmosis reduction, as shown by plain radiography, was approved by CT scanning (Figure 1). In this study, we found no patient with syndesmosis malreduction in CT imaging. The accuracy of plain radiography for diagnosing syndesmosis malreduction after ankle ORIF was determined 100%.

Discussion

This study showed that the sensitivity of plain radiography was high in diagnosing syndesmosis malreduction after ankle ORIF and based on this finding, it seems that postoperative CT scanning to evaluate syndesmosis reduction is not necessary.

Stability of the syndesmosis, which is the anatomical relationship between the tibia and fibula and plays an important role in the mortise architecture, is a vital prerequisite for normal ankle function and lack of this, is associated with pain and ankle instability and weakness (12, 13). Also, lack of treatment or improper treatment of syndesmosis injuries can result in latent diastasis, chronic instability, further injury, arthritic changes, chronic pain, osteochondral lesions, and other sequelae (26). Sagi *et al* examined the correlation between syndesmosis malreduction and functional outcome after at least two years of follow-up and found that patients with malreduction have worse functional outcomes based on the Short Form Musculoskeletal Assessment and Olerud-Molander questionnaires. Moreover, they observed that open reduction of the syndesmosis results in a substantially lower rate of malreduction (27). For this reason, examining syndesmosis stability and reduction is crucial in assessing patients with ankle traumas. However, there is an important drawback with examining syndesmosis reduction in patients with ankle fracture and it is that the appropriate method for the assessment of syndesmosis reduction in ankle fractures remains controversial (1, 14-22). Currently, we have no definite quantitative parameters for examining and diagnosing syndesmosis injuries and most clinical trials with greater sample sizes are required (14, 25, 28).

CT scanning is the main method for assessing syndesmosis reduction and the advantages of this method in diagnosing syndesmosis injuries are shown in several studies (29-31). However, due to limited studies efforts to find some quantitative criteria for normal syndesmosis on CT imaging, the diagnostic efficacy of this method for detection of syndesmosis malreduction is to some extent controversial (25, 32). Also, in spite of several advantages of CT scanning, plain radiography is rapid and inexpensive and in the case of acceptable diagnostic efficacy for diagnosing syndesmosis malreduction, can be a proper option to assess syndesmosis. Several authors have investigated the adequacy of plain radiography in diagnosing syndesmosis injuries compared to other methods.

Jenkinson *et al* compared the intraoperative fluoroscopic stress testing, static radiographs, and biomechanical criteria for the diagnosis of syndesmosis instability in 38 patients with external rotation type ankle fractures and found that preoperative radiographs and biomechanical criteria are not appropriate methods to detect syndesmosis instability. Moreover, they advised intraoperative stress fluoroscopy as a valuable tool to detect unstable syndesmosis injuries (33). Takao *et al* compared the accuracy of standard anteroposterior (AP) radiography, mortise radiography and MRI with arthroscopy of the ankle to diagnosis syndesmosis disruption in 52 patients. They found that in comparison with arthroscopy, the sensitivity, specificity and accuracy were 44.1%, 100% and 63.5% for standard AP radiography and 58.3%, 100% and 71.2% for mortise radiography. For MRI they were 100%, 93.1% and 96.2% for a tear of the anterior inferior tibiofibular ligament and 100%, 100% and 100% for a tear of the posterior inferior tibiofibular ligament. They concluded that AP and mortise radiography did not provide a correct diagnosis, contraty to MRI imaging. However, Takao *et al* demonstrated that ankle arthroscopy is crucial for the accurate diagnosis of a tear of the tibiofibular syndesmosis (6). Also, Lui *et al* compared the intraoperative stress radiographic and arthroscopic diagnosis of syndesmosis disruption in 53 patients with acute ankle fractures (type B or C based on the Weber classification) and found that ankle arthroscopy is superior to intraoperative stress radiography in diagnosising syndesmosis disruption (5). In another study, Oae *et al* compared the diagnostic value of MRI and arthroscopy in syndesmosis injuries in 58 patients with ankle sprain or distal fibular fracture. They considered ligament disruption when MRI showed ligament discontinuity or nonvisualization of the ligament and concluded that MRI using the both criteria is highly accurate to diagnose syndesmosis injury (4). Also, Paredes-Vázquez *et al* compared the diagnostic efficacy of plain radiography and CT scanning in syndesmosis diastasis and showed that the ability of plain radiography is questionable to define the syndesmosis diastasis and the CT scanning should be used in cases of a doubtful diagnosis (34).

As mentioned above, most of the studies have shown that plain radiography is not an appropriate diagnostic method for syndesmosis disruption. However, it is of importance that most of these studies have evaluated the diagnostic value of radiography before operating and postoperative diagnostic value has been limitedly investigated. Gardner *et al* determined the adequacy of standard postoperative radiographic measurements in assessing syndesmosis reduction compared to CT in 25 patients with ankle fractures and syndesmosis instability, who underwent open reduction and syndesmosis fixation. Postoperative standard radiography and CT scanning were performed for all patients. In the CT scan, if the distance between the fibula and the anterior and posterior facets of the incisura was >2 mm, the syndesmosis was considered as incongruous. The sensitivity and specificity of the radiographs were 31% and 83%, respectively. Gardner *et al* concluded that radiographic measurements were not accurate in diagnosing syndesmosis malreduction and postoperative radiographic measurements were not accurate to assess the quality of the reduction (23). Sagi *et al* found that after the operation, 39% of the patients had syndesmosis malreduction and they recommended that surgeons obtain a postoperative CT scan in order to compare it to the healthy side (27). In addition to these findings, important orthopedic literature recommends obtaining a postoperative CT scan to assess the quality of syndesmosis reduction (24). Also, nowadays there are portable CT scanners used for intraoperative evaluations in some medical centers.

The above-mentioned findings and lack of sufficient studies have propelled us to perform the current study. In

other words, we have tried to find out whether postoperative CT scanning is necessary to assess the quality of syndesmosis reduction in patients with ankle fracture and syndesmosis disruption. However, in contrast to previous studies, we have found that plain radiography is an accurate and appropriate tool that can reflect the status of syndesmosis after the operation and mainly due to that we reoperated on those patients who were diagnosed with had syndesmosis malreduction in the postoperative plain radiography.

In this study, we used the contralateral ankle as the standard to evaluate the quality of reduction and congruity of the fractured side on CT imaging. Based on previous studies there is no quantitative parameter available to accurately evaluate the status of the syndesmosis and the authors have recommended using contralateral ankle CT images as the norm. Dikos et al. investigated the characteristics of normal tibiofibular relationships on CT images and have shown that due to significant anatomic variations between individuals, comparing a patient's ankles together provides a precise definition of normal tibiofibular relationships (25). Also, Mukhopadhyay et al. have shown the need for an individual assessment method for diagnosing the malreduction of syndesmosis (28).

Plain radiography is an accurate method to diagnose syndesmosis malreduction after ankle ORIF. Based on the findings of our study, postoperative CT scanning is not necessary after ankle ORIF to assess the quality of syndesmosis reduction.

Alireza Manafi Rasi MD
Gholamhossein Kazemian MD
Mohamad M Omidian MD
Ali Nemati MD

Department of Orthopedic Surgery
Imam Hossein Hospital
Shahid Beheshti University of Medical Sciences
Tehran, Iran

References

1. Bartonícek J. Anatomy of the tibiofibular syndesmosis and its clinical relevance. Surg Radiol Anat. 2003;25(5-6):379-86.
2. 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; 65:666-77.
3. van den Bekerom MP, Haverkamp D, Kerkhoffs GM, van Dijk CN. Syndesmosis stabilization in pronation external rotation ankle fractures. Clin Orthop Relat Res. 2010;468(4):991-5.
4. Oae K, Takao M, Naito K, Uchio Y, Kono T, Ishida J, Ochi M. Injury of the tibiofibular syndesmosis: value of MR imaging for diagnosis. Radiology. 2003;227(1):155-61.
5. Lui TH, Ip K, Chow HT. Comparison of radiologic and arthroscopic diagnoses of distal tibiofibular syndesmosis disruption in acute ankle fracture. Arthroscopy. 2005;21(11):1370.
6. Takao M, Ochi M, Oae K, Naito K, Uchio Y. Diagnosis of a tear of the tibiofibular syndesmosis. The role of arthroscopy of the ankle.J Bone Joint Surg Br. 2003;85(3):324-9.
7. Hermans JJ, Beumer A, Hop WC, Moonen AF, Ginai AZ. Tibiofibular syndesmosis in acute ankle fractures: additional value of an oblique MR image plane. Skeletal Radiol. 2012;41(2):193-202.
8. Hermans JJ, Beumer A, Hop WC, Moonen AF, Ginai AZ. Tibiofibular syndesmosis in acute ankle fractures: additional value of an oblique MR image plane.Skeletal Radiol. 2012;41(2):193-202.
9. Kennedy JG, Johnson SM, Collins AL, DalloVedova P, McManus WF, Hynes DM, et al. An evaluation of the Weber classification of ankle fractures. Injury. 1998;29(8):577-80.
10. Court-Brown CM, McBirnie J, Wilson G. Adult ankle fractures-an increasing problem? Acta Orthop Scand. 1998;69(1):43-7.
11. Lindsjo U. Operative treatment of ankle fractures. Acta Orthop Scand. 1981;189:1-131.
12. Wagener ML, Beumer A, Swierstra BA. Chronicinstability of the anterior tibiofibular syndesmosis of the ankle. Arthroscopic findings and results of anatomical reconstruction. BMC Musculoskelet Disord. 2011;12:212.
13. Taser F, Shafiq Q, Ebraheim NA. Three-dimensional volume rendering of tibiofibular joint space and quantitative analysis of change in volume due to tibiofibular syndesmosis diastases. Skeletal Radiol. 2006;35(12):935-41.
14. Liu X, Yu G.Progress in diagnosis and treatment of distal tibiofibular syndesmosis injury.Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2012;26(5):612-6.
15. Yamaguchi K, Martin CH, Boden SD, Labropoulos PA. Operative treatment of syndesmosis disruptions without use of a syndesmosis screw: a prospective clinical study. Foot Ankle Int. 1994;1(8):407-14.
16. Weening B, Bhandari M. Predictors of functional outcome following transsyndesmosis screw fixation of ankle fractures. J Orthop Trauma. 2005;19(2):102-8.
17. Ramsey PL, Hamilton W. Changes in tibiotalar area of contact caused by lateral talar shift. J Bone Joint Surg

Am. 1976;58(3):356-7.
18. Cedell CA. Total rupture of the syndesmosis in the ankle joint. Lakartidningen. 1969;66(23):2427-33.
19. Nelson OA. Examination and repair of the AIT-FL in transmalleolar fractures. J Orthop Trauma. 2006;20(9):637-43.
20. Hovis WD, aiser BW, Watson JT, Bucholz RW. Treatment of syndesmosis disruptions of the ankle with bioabsorbable screw fixation. J Bone Joint Surg Am. 2002;84(1):26-31.
21. Kennedy JG, Soffe KE, Dalla Vedova P, Stephens MM, O'Brien T, Walsh MG, et al. Evaluation of the syndesmosis screw in low Weber C ankle fractures. J Orthop Trauma. 2000;14(5):359-66.
22. Chissell HR, Jones J. The influence of a diastasis screw on the outcome of Weber type-C ankle fractures. J Bone Joint Surg Br. 1995;77(3):435-8.
23. Gardner MJ, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG. Malreduction of the tibiofibular syndesmosis in ankle fractures.Foot Ankle Int. 2006;27(10):788-92.
24. Davidovitch RI, Egol KA. Ankle fractures. In: Bucholz RW, Court-Brown CM, Heckman JD, Tornetta III P. Rockwood and Green's fractures in adults. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2010: 1974-2021.
25. Dikos GD, Heisler J, Choplin RH, Weber TG. Normal tibiofibular relationships at the syndesmosis on axial CT imaging.J Orthop Trauma. 2012;26(7):433-8.
26. Porter DA. Evaluation and treatment of ankle syndesmosis injuries. Instr Course Lect. 2009;58:575-81.
27. Sagi HC, Shah AR, Sanders RW. The functional consequence of syndesmosis joint malreduction at a minimum 2-year follow-up. J Orthop Trauma. 2012; 26(7):439-43.
28. Mukhopadhyay S, Metcalfe A, Guha AR, Mohanty K, Hemmadi S, Lyons K, O'Doherty D. Malreduction of syndesmosis--are we considering the anatomical variation? Injury. 2011;42(10):1073-6.
29. Ebraheim NA, Lu J, Yang H, Mekhail AO, Yeasting RA. Radiographic and CT evaluation of tibiofibular syndesmosis diastasis: a cadaver study. Foot Ankle. 1997;18(11):693-8.
30. Sclafani SJ. Ligamentous injury of the lower tibiofibular syndesmosis: radiographic evidence. Radiology. 1985;156:21-7.
31. Harper MC. An anatomic and radiologic investigation of the tibiofibular clear space. Foot Ankle Int. 1993;14:455-8.
32. Elgafy H, Semaan HB, Blessinger B, Wassef A, Ebraheim NA. Computed tomography of normal distal tibiofibular syndesmosis.Skeletal Radiol. 2010;39(6):559-64.
33. Jenkinson RJ, Sanders DW, Macleod MD, Domonkos A, Lydestadt J. Intraoperative diagnosis of syndesmosis injuries in external rotation ankle fractures. J Orthop Trauma. 2005;19(9):604-9.
34. Paredes-Vázquez R, Sesma-Villalpando RA, Herrera-Tenorio G, Romero-Ogawa T. CT scan evaluation of the syndesmosis diastasis in AO/OTA B and C ankle fractures. Acta Ortop Mex. 2011;25(1):32-8.