Original Article

False negative rate of syndesmotic injury in pronation-external rotation stage IV ankle fractures

Kwang-Soon Song, Sin-Gi Kim, Young-Jae Lim, Jong-Hyuk Jeon, Kyunng-Keun Min

Abstract

Background: To investigate false negative rate in the diagnosis of diastasis on initial static anteroposterior radiograph and reliability of intraoperative external rotational stress test for detection of concealed disruption of syndesmosis in pronation external rotation (PER) stage IV (Lauge-Hansen) ankle fractures.

Materials and Methods: We prospectively studied 34 PER stage IV ankle fractures between September 2001 and September 2008. Twenty (59%) patients show syndesmotic injury on initial anteroposterior radiographs. We performed an intraoperative external rotation stress test in other 14 patients with suspicious PER stage IV ankle fractures, which showed no defined syndesmotic injury on anteroposterior radiographs inspite of a medial malleolar fracture, an oblique fibular fracture above the syndesmosis and fracture of the posterior tubercle of the tibia.

Results: All 14 fractures showed different degrees of tibiofibular clear space (TFCS) and tibiofibular overlapping (TFO) on the external rotation stress test radiograph compared to the initial plain anteroposterior radiograph. It is important to understand the fracture pattern characterstic of PER stage IV ankle fractures even though it appears normal on anteroposterior radiographs, it is to be confirmed for the concealed syndesmotic injury through a routine intraoperative external rotational stress radiograph.

Key words: Ankle fracture, external rotation stress test, false negative, syndesmotic injury

Introduction

Syndesmotic disruption following an ankle fracture is common and usually the result of an external rotation force,[1-3] especially in pronation external rotation (PER) stage IV ankle injury[3,4] as per Lauge-Hansen classification[4-6] (Danis-Weber C-2, 3 type). Accurate reduction of syndesmosis of the distal tibiofibular joint is the single most important predictor of a favorable, functional outcome following surgery.[2,5] A combination of clinical examination and simple radiological findings[1,7,8] is the most common method used to diagnose a syndesmotic disruption. However, evidence of syndesmotic instability may not have been clearly evident upon an initial radiograph examination.[7,9-12] Only a few authors have reported limited false negative cases (4 of 7 patients: 57%) in diagnosis of syndesmotic ligament injury in PER stage IV ankle fracture on initial nonweight bearing static radiographs.[12] We investigated the rate of false negatives in the diagnosis of diastasis on initial static anteroposterior radiograph and studied the reliability of intraoperative external rotational stress test for detection of concealed disruption of syndesmosis in PER stage IV ankle fractures.

Department of Orthopedic Surgery, Keimyung University, Daegu, Korea

Address for correspondence: Prof. Kwang-Soon Song, Department of Orthopedic Surgery, School of Medicine, Keimyung University, 56 Dalsungro, Joong-gu, Daegu 700-712, Korea. E-mail: skspos@dsmc.or.kr

Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.118204

Materials and Methods

After obtaining informed consent from patients and the approval of our institutional review board, we prospectively studied consecutive 34 PER stage IV (Lauge-Hansen) ankle fractures between September 2001 and September 2008. There were 29 males and 5 females, with an average age of 42 years (range 20-71 years). PER stage IV ankle fracture was defined as transverse fracture of the medial malleolus or disruption of the deltoid ligament, disruption of the anterior tibiofibular ligament, spiral oblique fracture of the fibula relatively high above the level of the syndesmosis and rupture of posterior tibiofibular ligament or avulsion fracture of the posterolateral tibia in sequence.[3] We defined disruption of syndesmosis as the following: Preoperative or intraoperative anteroposterior radiograph that demonstrate a clear space of more than 6 mm between the medial wall of the fibula and the lateral wall of the posterior tibial malleolus, or distal tibiofibular overlapping (TFO) of less than 5 mm measured 1 cm proximal of the plafond.[3] Three experienced orthopedic surgeons were involved in assessment of the radiographic criteria and measurements were made using the Picture Archiving Communication System and manually on printed radiographs. We measured tibiofibular clear space (TFCS) and TFO preoperatively, intraoperatively and postoperatively on anteroposterior radiograph [Figure 1]. We also measured the level of fibular fracture as the distance from the tip of the lateral malleolus to the fracture site. TFCS and TFO distance in the unaffected normal side was taken as the control group in 12 cases. We performed intraoperative external rotation stress tests in 14 PER stage IV fractures with suspicious syndesmotic injury. Initial static anteroposterior radiographs did not reveal syndesmotic injury in these fractures although the fracture patterns (combined fracture, including medial malleolar fracture, relatively high fibular fracure and posterior lip fracture) showed evident PER stage IV. The stress test of the ankle was done with the foot in external rotation and ankle in neutral dorsiflexion under general anesthesia, before open reduction of the medial or lateral malleolus. The proximal tibia was stabilized using the assistant's hand while the examiner held the ankle in a neutral position (90° ankle dorsiflexion). All procedures including stress test and fixation of the fracture and syndesmotic instability were performed consistently by one surgeon (KSS). Consistent external rotational force was applied until the examiner felt resistance to further rotational force. There were no adverse events during the stress test.

Figure 1: Anteroposterior radiograph of ankle joint showing radiographic measurements, tibiofibular clear space (AB) and tibiofibular overlapping (BC)

RESULTS

For all 34 cases, the average level of fibular fracture was 124 mm (range 47-328 mm) from the tip of lateral malleolus. The average amount of initial TFCS was 7 mm (range 2-22 mm) and postoperative TFCS was 3 mm (range 1-6 mm) on the anteroposterior radiograph. The average amount of initial TFO was 4 mm (range 0-11 mm) and postoperative TFO was 8 mm (range 1-11 mm) on the anteroposterior radiograph.

In 20 cases showing defined disruption of syndesmotic ligament on initial plain anteroposterior radiograph, the average level of fibular fracture was 116 mm (range 47-328 mm) from the tip of the lateral malleolus. The average amount of initial TFCS was 9 mm (range 5-22 mm) postoperative TFCS was 3 mm (range 1-6 mm) on the anteroposterior radiograph. The average amount of initial TFO was 2 mm (range 0-8 mm) and postoperative TFO was 7 mm (range 1-11 mm) on the anteroposterior radiograph.

Fourteen (41%) patients were assessed intraoperatively by external rotation stress radiograph under the image intensifier [Figures 2 and 3]. All 14 fractures showed different degrees of TFCS and TFO on the external rotation stress test radiograph compared to the initial plain anteroposterior radiograph. The average degree of TFCS evident in these 14 fractures on the initial anteroposterior radiograph was 4 mm (range 2-5 mm) and the average degree of TFO was 7 mm (range 3-11 mm). The average amount of TFCS with the external stress test was 9 mm (range 6-11 mm) and the average of TFO was 1 mm (range 0-6 mm). An amount of TFCS and TFO with stress test fell under the criteria of disruption of syndesmotic ligament in all 14 cases. The average degree of difference of TFCS between initial radiograph and external rotation stress radiograph was 5 mm and the difference of overlapping was 6 mm.

The average amount of postoperative TFCS was 3 mm(range 1-6 mm). The average amount of postoperative TFO was 7 mm (range 1-11 mm) [Figure 4]. Interestingly, a difference was observed in the level of fibular fracture between the two groups. Fourteen cases in which stress tests were performed showed fibular fractures distance measured from the tip of lateral malleolus 20 mm (mean value) higher as compared to 20 cases, which demonstrated syndesmotic injury on initial radiographs.

We noted 41% false negatives in the diagnosis of disruption of the syndesmotic ligament in PER stage IV ankle fractures on initial static anteroposterior radiograph. We identified disruption of the syndesmotic lesion through intraoperative external rotation stress tests in all 14 cases [Table 1].

Discussion

Failure to diagnose and stabilize syndesmotic disruption adversely affects out-comes.[7,10,13] When rotational ankle fractures presented with late syndesmotic instability, treatment options are limited and results are frequently unsatisfactory.[12] In unstable ankle fractures with syndesmotic injury, optimal treatment starts with a comprehensive evaluation that includes a thorough physical examination as well as imaging studies to assess for syndesmotic instability.[14] There is controversy regarding the effectiveness of standard radiographic analysis in the diagnosis of syndesmotic injury. Positioning of the ankle greatly influences the radiographic parameters and some authors believe that there are no optimal radiologic parameters to assess the integrity of the syndesmosis.[11,15,16] In contrast, increased TFCS is considered the most reliable indicator of syndesmotic injury[8,17] because the width of TFCS does not change significantly within an arc from 5° of external rotation to 25° of internal rotation and is not dependent on variations in the positioning of the extremity relative to the X-ray beam. Some authors reported the medial clear space as a reliable indicator of instability, only when it was taken in correlation with the patient's history and clinical findings.[14]

Several diagnostic methods, including computed tomogram,[18] magnetic resonance image (MRI)[19] and arthroscopy[13,20] were introduced and demonstrated superior accuracy. However, these methods are not cost effective and can be viewed as invasive.[12]

Preoperative radiographs and biomechanical criteria are currently unable to routinely predict the presence or absence of syndesmotic instability.[7,11,12,21] Syndesmotic

Table 1: Demography of patients

Case	Age (in years)	Gender	Level of the fibula fracture (cm)	Preoperative TFCS (mm)	TFCS in the stress test (mm)	Postoperative TFCS (mm)	Preoperative TFO (mm)	TFO in the stress test (mm)	Postoperative TFO (mm)
1	35	M	10.8	3	9	3	5	0	6
2	53	M	18.6	5	6	5	5	3	8
3	35	M	6.8	10		3	0		8
4	41	M	12	10		3	0		7
5	51	M	6.4	10		1	0		7
6	68	M	11.9	3	7	3	9	0	8
7	69	F	12.7	4	10	2	5	0	9
8	35	M	27.6	6		3	1		9
9	57	M	13	4	11	2	3	0	7
10	35	M	11	8		6	1		1
11	55	M	9.1	5		2	3		11
12	24	M	22.2	5	9	3	5	0	9
13	28	F	6	9		2	0		6
14	41	M	9.5	5	10	2	9	0	9
15	31	M	11	5		4	0		7
16	50	M	5	5		3	6		8
17	20	F	9	8		4	3		5
18	20	M	7.5	9		2	2		10
19	66	M	5.7	5	9	3	11	0	9
20	43		22.2	5		3	4		8
21	22	F	8.1	10		2	0		7
22	43	F	5.6	2	8	4	4	6	9
23	60	M	6.6	6		3	5		9
24	37	M	8.5	4	7	2	7	2	9
25	36	M	7.8	13		4	0		8
26	34	M	7.9	10		3	0		9
27	27	M	4.7	6		6	3		2
28	40	M	25	4	8	2	9	2	11
29	54	M	10.6	5	9	4	7	0	6
30	31	M	32.8	6		4	0		8
31	28	M	7.8	4	7	4	7	0	9
32	57	M	27	5	7	4	6	0	8
33	31	M	16.6	22		4	6		10
34	71	M	13.2	7		4	8		5

TFCS=Tibiofibular clear space, TFO=Tibiofibular overlapping injury as predicted by the Lauge-Hansen fracture classification correlated well with MRI findings. With MRI, the extent of syndesmotic injury and therefore fracture stage can be assessed more accurately compared to radiographs.[22] Combination of clinical examination and simple radiographs still play an important role in the early recognition of syndesmotic injuries.[1,7,8] Several authors recommended an intraoperative, external rotation stress test[2,12,14,15,23-25] or lateral stress test[26] under fluoroscopy, for the detection of unstable syndesmosis. Zalavras *et al*.[7] stressed that clinical history, physical examination and a routine intraoperative stress test is recommended for detection of syndesmotic instability. Jenkinson *et al*.[12] reported that intraoperative fluoroscopy detected associated syndesmotic ligament disruption in 4 of 7 patients (57%) with PER type ankle injuries (stage 3 and stage 4 together) that were not predicted by biomechanical criteria.

We prospectively performed routine intraoperative stress tests in 14 cases with no syndesmotic instability on initial anteroposterior radiographs and found concealed syndesmotic injury in suspicious PER stage IV fractures. We also found the intraoperative external rotation stress radiograph to be a very useful method for confirming concealed syndesmotic instability in PER stage IV ankle fractures. Takao *et al*.[20] reported 0% false positivity on standard anteroposterior radiography. Mortis radiography on 23 patients had a tear of the syndesmosis.[20] We also had no false positive cases in our 20 cases in whom syndesmotic injury was present on the initial static radiographs and obtained definite restoration of syndesmotic disruption after surgery [Table 1].

We conclude that it is important to understand the fracture pattern characteristic of PER stage IV ankle fractures even though it appears normal on anteroposterior radiographs, it is to be confirmed for the concealed syndesmotic injury through a routine intraoperative external rotational stress radiograph.

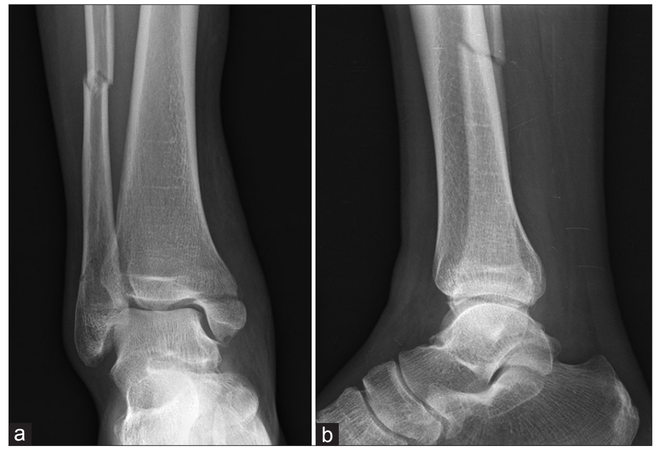

Figure 2: Anteroposterior (a) and lateral (b) radiographs of ankle, a 68 year old, male shows medial malleolar fracture at level of ankle plafond without disruption of distal tibiofibular joint on anteroposterior radiograph (a) and oblique fibular fracture (directed from antero-superior to postero-inferior) at 11.9 cm above from tip of lateral tip on lateral radiograph (b). This ankle fracture is typical pattern of pronation-external rotation type, stage III or IV, with high suspicion of syndesmotic injury of distal tibiofibular joint

Figure 3: Intraoperative fluoroscopy external rotation stress test showed typical pronation-external rotation, stage IV, with loss of normal tibiofibular overlapping and increased tibiofibular clearance space suggesting severe syndesmotic ligaments injury

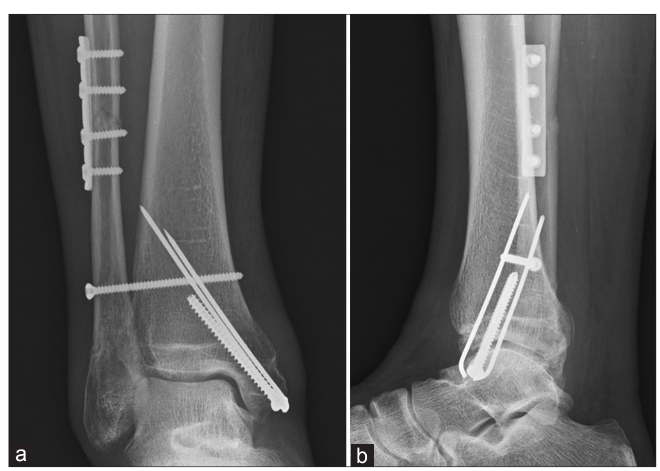

Figure 4: Postoperative anteroposterior (a) and lateral (b) radiograph showing implant *in situ*

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How to cite this article: Song K, Kim S, Lim Y, Jeon J, Min K. False negative rate of syndesmotic injury in pronation-external rotation stage IV ankle fractures. Indian J Orthop 2013;47:482-6.

Source of Support: Nil, **Conflict of Interest:** None.