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ORIGINAL ARTICLE

The additional value of gravity stress radiographs in predicting deep deltoid ligament integrity in supination external rotation ankle fractures

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Abstract

Objectives Goal of this study was to investigate whether a gravity stress radiograph is beneficial in determining instability in Supination-External rotation (SER)-type ankle fractures without a medial fracture.

Methods 39 Patients with a SER-type ankle fracture without a medial or posterior fracture and medial clear space (MCS) < 6 mm at regular mortise view were included. A gravity stress radiograph and Magnetic Resonance imaging (MRI)-scan were made. The MCS measurements of the regular and gravity stress radiographs were compared with the MRI findings (set as reference standard) to determine the sensitivity, specificity, and positive (PPV) and negative (NPV) predictive values as indication for a complete deltoid ligament rupture.

Results Mean MCS at regular mortise views was 3.11 (range 1.73–5.93) mm, compared to 4.54 (range 2.33–10.40) mm at gravity stress radiographs. With MCS ≥ 4 mm as threshold for predicting a complete rupture at regular ankle mortise views the sensitivity was 66.7, specificity 91.7, PPV 40.0 and NPV 97.0. Gravity stress radiographs with MCS ≥ 6 mm as threshold led to a sensitivity of 100, specificity 91.7, PPV 50.0 and NPV 100.

Conclusion Gravity stress radiographs have more discriminative ability for diagnosing SER-type fractures with or without a complete deltoid ligament tear than regular ankle mortise views.

Keywords Lateral malleolus fractures · Joint instability · Diagnostic imaging · Overtreatment · Predictive value

Abbreviations

SER	Supination-external rotation
MCS	Medial clear space
MRI	Magnetic resonance imaging
PPV	Positive predictive value
NPV	Negative predictive value
DDL	Deep deltoid ligament
SCS	Superior clear space
VAS	Visual Analogue Scale
AITFL	Anterior inferior tibiofibular ligament
PITFL	Posterior inferior tibiofibular ligament

Introduction

Supination-external rotation (Lauge–Hansen SER) Weber B-type ankle fractures are among the most common injuries seen at the Emergency Department [1]. The decision whether to operate or treat conservatively is principally based on the stability of the ankle. The syndesmosis of the ankle, the tibiofibular ligaments and interosseous membrane, are stabilisers of the ankle. However, the deep deltoid ligament (DDL) is, together with the medial malleolus, the main stabiliser of the ankle joint during axial load [2]. Fibular fractures without medial injury are considered stable and most surgeons advocate conservative treatment, because nonoperative treatments have good clinical outcomes [3–5]. On the other hand, a bimalleolar or a bimalleolar equivalent fracture, i.e., a fibular fracture with additional deep deltoid ligament rupture, will be unstable due to the incompetent lateral and medial restraints of the ankle and requires operative treatment [1, 6].

Accurate exclusion of medial injury in a SER ankle injury with an isolated lateral malleolus fracture is of great clinical

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importance, because this information confirms the choice of safe conservative management.

Widening of the medial clear space (MCS) at a mortise X-ray view is used to predict and indicate a DDL rupture. However, the latter might lead to surgical overtreatment of stable ankle fractures [7].

According to several authors, magnetic resonance imaging (MRI) is considered the reference standard for detecting DDL rupture [8–10]. However, recognized disadvantages of MRI are its availability and costs. An alternative tool for MRI is the gravity stress radiograph. In this examination, a radiograph is performed anteroposteriorly with the leg horizontal (medial side up) without ankle support. A complete deltoid rupture in the absence of a talar shift on the conventional mortise view may thus be detected by manifest widening of the MCS on this additional radiograph. To our knowledge, so far no research has reported the diagnostic accuracy of the gravity stress radiograph compared with the results of MRI [3, 11–13].

The purpose of the current study is to examine the additional diagnostic value of the gravity stress radiograph in determining deltoid ligament disruption in ankle fractures. The sensitivity and specificity of this test will be compared with findings on MRI, which is used as the reference standard.

Patients and methods

All patients, aged between 18 and 70 years, who were admitted to the Emergency Department of our centre between May 2014 and November 2015 and diagnosed with a supination-external rotation (SER) Weber B-type fibular fracture (unimalleolar) were informed and received an information guide about the study. Patients with a widening of the MCS ≥ 6 mm on conventional mortise view were excluded from the study and received operative treatment according to the local protocol. Additionally, patients with any contraindication to undergo MRI, mentally incompetent patients or patients with no mastery of our national language were excluded from the study. After informed consent to participate in the study, MRI protocol of the ankle and a gravity stress radiograph (by an instructed radiology technician) were made within 1 week of the initial injury. All patients were treated with a cast in the period in between. The decision whether to operate or treat conservatively was made by the attending surgeon. The follow-up of all patients took place with predefined intervals.

The gravity stress radiograph was performed with the patient in the lateral decubitus position with the injured ankle dependent off the end of the table. Directly after having positioned the patient, the radiograph can be made by the technician. To approach a standard radiological mortise view an internal rotation of the tibia of approximately 10° was required. Figure 1 illustrates acquisition of a gravity stress radiograph. There was no need for local anaesthetic agents in any of the patients undergoing this examination.

Magnetic resonance imaging was performed on two clinical 1.5-T magnetic resonance units (Magnetom Avanto and Magnetom Symphony, Siemens Healthcare, Erlangen, Germany).

The patients were examined in the supine position with the injured extremity placed in an extremity coil in a neutral position without a cast.

The performed MRI protocol consisted of 3–4 mm-thick three-plane proton-density weighted turbo spin-echo fat suppressed images, 3–4 mm-thick sagittal and transaxial T1-weighted spin-echo images and 3 mm-thick coronal T2-weighted turbo spin-echo fat suppressed images. (Table 1).

Fig. 1 The optimal positioning to obtain a gravity view. The leg was positioned horizontally with the medial side up. The ankle and foot were free of any external support

Table 1 Ankle MRI protocol at 1.5 T

	PD TSE fs sag	PD TSE fs cor	PD TSE fs tra	T1W SE sag	T1W SE tra	T2W TSE fs cor
Voxel (mm)	0.5×0.5×3	0.4×0.4×3	0.4×0.4×4	0.7×0.5×3	0.8×0.4×4	0.5×0.3×3
Slices (mm)	22 × distance 20%	27 × distance 25%	27 × distance 20%	22 × distance 20%	26 × distance 20%	28 × distance 20%
FOV (mm)	160	140	140	160	140	140
FOV phase	100	100	100	100	100	100
TR (ms)	2380	2920	2990	504	583	2530
TE (ms)	33	33	33	14	14	70
NSA	2	2	2	1	1	2
Phase enc	AP	RL	AP	AP	AP	RL
Turbofactor	7	7	7	1	1	15

Protocols are performed at 1.5-T magnetic resonance units (Magnetom Avanto and Magnetom Symphony, Siemens Healthcare, Erlangen, Germany)

FOV field of view, *FS* fat saturation, *NSA* number of signals acquired, *PD* proton density-weighted, *TE* echo time, *TR* repetition time, *TSE* Turbo spin-echo

Fig. 2 The medial clear space was measured as a perpendicular line from the medial talar surface to the lateral surface of the medial malleolus

The MCS was measured as a horizontal line drawn from the medial talar surface at the level of the talar dome to the lateral surface of the medial malleolus (Fig. 2). It was measured by using a digital calibrated ruler in Zillion PACS Viewer by Rogan, Delft. The cut-off value for widening of the MCS for the conventional mortise view was ≥ 4, and 5 and 6 mm for the gravity stress radiograph. The superior clear space (SCS) was measured as the vertical distance of the lateral tibiotalar articulation.

The DDL was optimally interpretable on the coronal proton-density images and was graded as intact, oedematous, partially torn or completely torn. The intact DDL was isointense with continuous fibres with a striated appearance. In case of an oedematous ligament there was a T2 hyperintense signal intensity with an intact striated appearance. The partially torn ligament showed an irregular contour and partially disrupted fibres with a T2 hyperintense signal intensity caused by oedema. The complete torn ligament (all four parts) showed a complete discontinuity of the fibres and a T2 hyperintense signal intensity due to a full thickness defect of the DDL.

The MCS was measured independently on both the regular mortise view and the gravity stress radiograph by 2 trauma surgeons and a musculoskeletal radiologist, who were unaware of the clinical findings. The mean results were compared with the results of the MRI, which were retrospectively and scored by consensus interpretation (by a trained musculoskeletal radiologist with over 4 years experience and a resident in his fifth year) with particular attention to the integrity of the deep deltoid ligament. According to the general classification, the integrity of the deep deltoid ligament on MRI was categorized as: normal, intact but presence of oedema, partial rupture, and total rupture [14].

With an expected specificity of the gravity stress radiograph of 0.9, a statistical power analysis showed that a size of 33 patients would be able to detect a significant difference between the two types of radiographs.

Using cross-tabs, the sensitivity, specificity, negative predictive value and positive predictive value of both the regular mortise and gravity stress mortise views were calculated. Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS), version 24.0.

Approval of the regional Medical Ethical Committee was obtained for this study.

Results

A total of 39 patients fulfilled the inclusion and exclusion criteria for this study. The mean MCS on the regular mortise view was 3.11 ± 0.84 mm (1.73–5.93), while on the gravity stress radiograph the mean MCS widening was 4.54 ± 1.56 mm (2.33–10.40). The sample represented normal distribution.

Classifying the MCS into groups, the conventional mortise view showed a MCS widening of ≤ 3 mm in 21 patients (53.8%), a widening in between 3 and 3.5 mm in 7 patients (17.9%), a widening of 3.5-4 mm in 6 patients (15.4%) and a widening of ≥ 4 mm in 5 patients (12.8%).

The gravity stress radiograph group was divided in 28 patients (72%) with a MCS widening of ≤ 5 mm, 6 patients (15.4%) with a MCS widening of between 5 and 6 mm and 5 patients (12.8%) with a MCS widening of ≥ 6 mm.

According to MRI, made within 1 week after initial trauma, in 20 patients (51.3%) the deltoid ligament was valued normal, in 12 patients (33.3%) there was oedema, 4 patients (7.7%) had a partially ruptured ligament and in 3 patients (7.7%) the ligament was completely ruptured. Moreover, the different ligaments of the syndesmosis, the anterior inferior tibiofibular ligament (AITFL) and the posterior inferior tibiofibular ligament (PITFL) and a fracture of the posterior malleolus were also analysed. In all but one patient, the AITFL was completely ruptured. These results are shown in Table 2.

An absolute MCS positive cut-off value of ≥ 4 mm on the conventional mortise X-ray was 66.7% sensitive and 91.7% specific for the diagnosis of a deep deltoid ligament disruption, corresponding to a positive and negative predictive value of respectively 40 and 97%.

An alternative measurement technique, using a 4-mm absolute MCS-positive cut-off value, with the MCS value being 1 mm greater than the superior clear space (SCS), was 73% sensitive and 46% specific for the diagnosis of a deep deltoid ligament tear [15].

The gravity view was 100% sensitive, 91.7% specific, 50% positive predictive, and 100% negative predictive with MCS ≥ 6 mm as cut-off value. These results are shown in Table 3.

Receiver operating characteristics (ROC) curves with area under the curves (AUC) are shown in Fig. 3.

The mean dislocation of the fibula fracture on conventional mortise view (measured as the maximum dislocation on either the lateral or anterior-posterior radiograph) was 1.66 mm (0–5.0), in 15 patients there was a dislocation of ≥ 2 mm. The mean dislocation of the fibula on the gravity stress view was 2.09 mm (0–5.5), with a dislocation of ≥ 2 mm in 18 patients.

Discussion

One of the most common ankle fractures is the supination-external rotation type injury. The Lauge–Hansen classification, first described in 1954, is based on the position and subsequently the movements of the foot as a result of its deforming force [16]. This type of injury can be stable (SE-type II without DDL rupture) or unstable (SE-type IV with medial fracture or DDL rupture). In stable ankle fractures non-operative treatment is the treatment of choice leading to excellent function in a high percentage of cases, even despite fibular displacement up to 5 mm [3, 5, 17–21].

The most important goal is the ability to select patients with a stable ankle fracture in order to safely treat them non-operatively. To be able to evaluate the integrity of the DDL, and thereby choice of optimal treatment, it is necessary and important to have an accurate diagnostic tool.

Currently, no consensus exists on the best test for diagnosing a DDL rupture, and thus identification of an unstable ankle. Recent studies show that the predictive value of physical examination to distinguish between stable or unstable fractures is not sufficient. Therefore, an additional diagnostic tool is necessary [8, 15, 22]. The mortise radiograph is the most commonly used tool nowadays. According to most studies, a MCS width of ≥ 4 mm on radiograph suggests a total tear of the DDL [23]. However, in 7.7% of the patients with a MCS widening of ≥ 6 mm the DDL is still (partially) intact and in patients with a MCS widening of < 6 mm this percentage is even higher [24]. Consequently, this MCS cut-off value of ≥ 4 mm might lead to surgical overtreatment of stable ankle fractures.

This is also reported by Murphy et al. [25], who identified patient-specific factors that produce differences in MCS measurements. This study calls into question the widespread use of an MCS measurement of 4 or 5 mm as the threshold in determining surgical versus nonsurgical treatment of Weber B fractures. Particularly men and people of tall stature are at risk for a false-positive diagnosis of DDL rupture. They concluded that a threshold value for MCS of 4 or 5 mm will lead to operative invention for some patients with SER-II fractures who could have been reliably treated nonoperatively.

The gold standard for identifying a DDL rupture is a (open or arthroscopic) surgical exploration of the ankle. It is obviously not ethical nor desirable to perform this invasive procedure in all patients presenting with a SER-type fracture with an intact medial malleolus. Magnetic resonance imaging (MRI) has met most requirements to make an adequate distinction between a stable and unstable

Table 2 Results of the MRI analyses

Patient	Regular mortise			Gravity mortise	MRI				Surgery	
	MCS	SCS	Fibular dislocation	MCS	AITFL	PITFL	Posterior fracture	Deltoid ligament	Yes/no	Surgery type
1	1.7	2.6	2.3	2.3	3	1	No	1	No	
2	2.0	2.9	1.6	2.8	3	3	No	1	No	
3	2.1	2.2	0	3.3	1	1	Yes	1	No	
4	2.2	2.4	0	2.8	3	1	Yes	1	No	
5	2.2	2.5	4.2	3.4	3	1	No	1	No	
6	2.4	2.6	1.4	3.6	3	1	No	1	No	
7	2.4	3.4	4	3.6	3	1	No	1	No	
8	2.5	3.9	1.2	3.6	3	1	No	2	No	
9	2.5	2.5	1	4.0	3	1	No	1	No	
10	2.5	3.0	1.3	5.1	3	1	No	1	No	
11	2.5	2.9	0	2.6	3	2	Yes	2	No	
12	2.5	3.4	1.9	5.5	3	3	Yes	1	No	
13	2.6	3.1	2.2	5.0	3	1	No	1	No	
14	2.6	3.5	1.9	4.6	3	1	No	1	No	
15	2.6	3.7	2.3	4.0	3	1	No	1	No	
16	2.7	3.2	2.2	3.4	3	3	No	1	No	
17	2.7	3.5	0.7	4.4	3	1	Yes	1	No	
18	2.8	2.8	1.3	3.2	3	1	No	1	No	
19	2.9	2.8	0	4.0	3	1	Yes	1	No	
20	3.0	3.3	1.5	2.8	3	1	No	1	Yes	lag screw with neutralisation plate
21	3.0	3.1	2.4	4.5	3	1	Yes	2	No	
22	3.1	3.2	1.5	4.3	3	2	No	1	No	
23	3.1	3.4	0	4.7	3	1	Yes	1	No	
24	3.1	3.0	3.2	6.3	3	3	Yes	1	Yes	lag screw with neutralisation plate
25	3.2	3.1	0	3.3	3	1	Yes	1	No	
26	3.2	2.8	1	4.7	3	2	No	1	No	
27	3.4	3.3	2.7	5.3	3	1	Yes	1	Yes	neutralisation plate
28	3.4	3.4	0	4.3	3	1	No	1	No	
29	3.6	3.4	2	6.0	3	1	No	3	Yes	lag screw with neutralisation plate
30	3.7	3.6	1.2	4.7	3	1	No	1	No	
31	3.7	3.4	1.7	5.7	3	3	No	1	Yes	2 lagscrews
32	3.8	2.7	2	4.0	3	1	No	1	No	
33	3.8	3.1	2	4.2	3	1	No	1	No	
34	3.9	3.6	0	4.4	3	1	No	1	No	
35	4.1	4.3	0	10.4	3	3	Yes	2	Yes	neutralisation plate
36	4.4	3.4	5	7.2	3	1	No	3	Yes	lag screw with neutralisation plate
37	4.7	4.4	3.8	7.0	3	1	No	1	Yes	lag screw with neutralisation plate
38	5.1	3.1	1.3	5.9	3	1	Yes	1	No	
39	5.9	3.8	3.8	7.1	3	1	No	1	Yes	lag screw with neutralisation plate

Ligament scoring: 1: intact; 2: partial rupture; 3: complete rupture

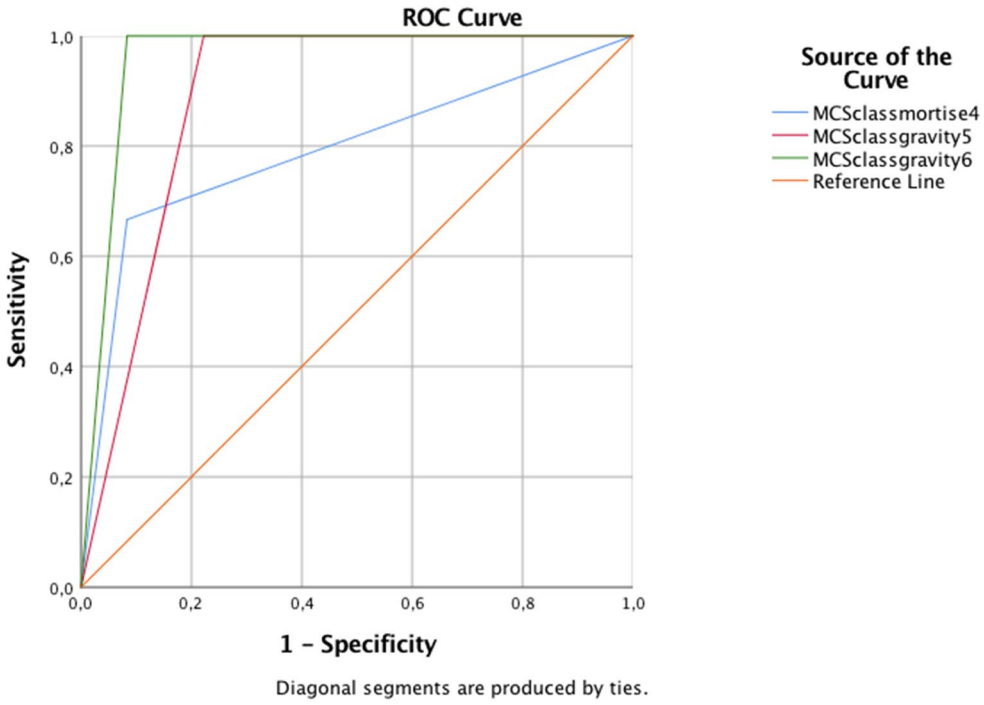
MCS medial clear space, *AITFL* anterior inferior tibiofibular ligament, *PITFL* posterior inferior tibiofibular ligament

ankle [9]. The posterior part of the DDL, the posterior deep tibiotalar ligament (PDTL), is the most contributing part of the ligament for the stability of the ankle and is perceptible in most of the patients with the use of MRI [26]. Frequent utilization of this method, however, has two main disadvantages. First of all, it is not feasible to perform MRI in all patients with an ankle fracture. Due to limitations in availability, MRI may not be used for this purpose

Table 3 Summary of predictive accuracy for different radiographs MCS values

	Sensitivity (%)	Specificity (%)	PPV	NPV
Conventional Mortise View: MCS ≥ 4 mm	66.7	91.7	40	97
Conventional Mortise View: MCS ≥ 4 mm and ≥ 1 mm SCS	33.3	93.9	33.3	93.9
Gravity stress radiograph: MCS ≥ 5 mm	100	72.2	23.1	100
Gravity stress radiograph: MCS ≥ 6 mm	100	91.7	50	100

MCS medial clear space, *SCS* superior clear space, *PPV* positive predictive value, *NPV* negative predictive value



Area Under the Curve

Test Result Variable(s)	Area
MCSclassmortise4	,792
MCSclassgravity5	,889
MCSclassgravity6	,958

Fig. 3 Receiver operating characteristics curves (ROC) with area under the curves (AUC) for the different cut-off values: MCS ≥ 4 mm on mortise view, MCS ≥ 5 mm on gravity view, MCS ≥ 6 mm on gravity view

in some centers or regions. Moreover, the MRI scan is a rather expensive tool to use in this context.

Research has been done to find alternative radiographic tools as reliable predictor for ligament injury. Ultrasound is one of the examinations being investigated, while being a safe and portable tool to use in the Emergency Department. Two studies found good results with 100% specificity and sensitivity for detecting DDL rupture [27, 28]. However, the numbers of patients in these studies were very small. Furthermore, radiologists with sufficient expertise to perform these ultrasounds are not always present in-hospital.

Another radiographic method is the manual stress radiograph in which the tibia is internally rotated to obtain a mortise view, followed by manual dorsiflexion and external rotation of the foot [13]. This is considered a painful method for patients and is not usually done without the use of anaesthetics.

Schottel et al. [29] investigated 52 patients with ankle fractures and compared MRI results with the results of this

manual stress ankle radiograph. They found a sensitivity and specificity of 66 and 77% respectively in diagnosing a complete rupture of the DDL.

Koval et al. [30] also studied the predictive value of this stress ankle test radiograph in detecting DDL rupture compared to MRI and concluded that the ankle stress test can indeed be used to prevent MRI in all patients with MCS widening on standard mortise radiograph. They found that 90% of the patients with a positive manual stress test, i.e., MCS widening of ≥ 4 mm, had evidence of only a partially torn DDL on MRI. Disadvantages of this type of radiograph are the degree of ankle joint flexion influencing the results [31] and the amount of force needed to perform the radiograph is not standardised [23].

Another type of stress radiograph is the weight-bearing radiograph that was investigated and reported by several authors [32–35]. Fractures of the lateral malleolus that were classified stable, according to the weight-bearing radiograph, were being treated conservatively. This resulted in radiographic—and clinical union without dislocation and a good functional outcome in all patients. The accuracy of this test, however, has not yet been thoroughly investigated in comparison with surgical exploration or MRI. Moreover, a cadaveric study by Stewart found no widening of the MCS during axial load spiral fibula fractures with rupture of DDL [36]. Therefore, this radiograph might underestimate the degree of instability.

An alternative method of detecting DDL rupture to discuss, investigated in the current study, concerns the gravity stress radiograph. For this radiograph, the patient lies down horizontally with the medial side of the ankle up, with the ankle and foot free of any external support. In theory, the medial clear space only widens in presence of a distal fibular fracture in combination with a complete deltoid rupture, and no shift will occur in lack of a complete deltoid rupture, thereby confirming stability. Figure 4 shows a normal congruent ankle joint at the standard mortise view with an equally normal gravity stress radiograph with no MCS widening. On the contrary, Fig. 5 shows a standard mortise view with no abnormalities, but a gravity stress radiograph with significant widening of the MCS and thus clear instability. Michelson et al. were the first to investigate this type of radiograph and found a promising specificity and sensitivity of 100% to detect a DDL rupture. However, this was a cadaveric study with only eight lower extremities [11].

Talar shift occurred only when the DDL, and not only the superficial part, was ruptured. Instability seen on this simple radiographic method was considered a useful indication for surgery in patients with an ankle fracture without talar displacement on standard mortise view. They concluded that the gravity stress radiograph can be regarded as a simple method, in which there is no need to put extra force on the patients' already painful ankle. Therefore, this could be an alternative practical diagnostic tool to be used in the Emergency Department. However, they did not compare their results with a reference standard.

Gill [13] and Schock [12] did compare results of the external rotation test and the gravity stress radiograph and both did not find significant differences in measurements of the MCS. The gravity stress view was experienced less painful than the external rotation test, with a Visual Analogue Scale (VAS) score [37] of respectively 3.4 vs. 6.1. They

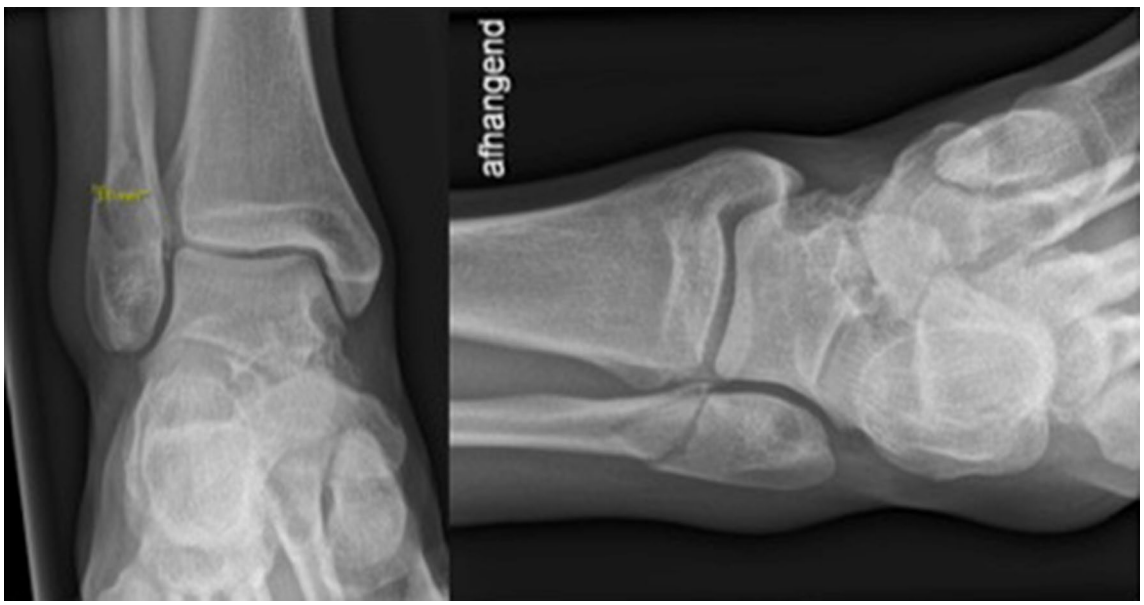


Fig. 4 Conventional mortise view and a gravity stress view, both with no widening of MCS

Fig. 5 No widening of MCS on the conventional mortise view. Clear MCS widening on the gravity stress view

concluded that this examination can be used as the initial diagnostic screening examination for the detection of occult medial ligamentous injuries in SER fractures of the ankle.

To our knowledge, this present study is the first clinical study that prospectively compares the gravity stress radiograph with MRI findings. We found that the gravity stress radiograph with MCS ≥ 6 mm as cut-off value has a 100% sensitivity and 91.7 specificity compared to the MRI, with a negative predictive value of 100%. These results are worse with MCS ≥ 5 mm as cut-off value. This confirms the conclusions of Holmes et al., who stated that traditional threshold values of 4 or 5 mm for MCS on gravity stress radiographs may overestimate instability in these injuries because the average MCS on such radiographs in their population was 4.42 mm. In their clinic, patients were excluded and planned for surgery if the MCS was > 7 mm, 2 mm greater than the SCS, or 2 mm greater than the contralateral MCS. Even patients with an MCS between 5.0 and 6.0 mm on initial gravity stress had no MCS widening during follow-up and good clinical outcomes. Despite this high average measurement, all patients in their study group were treated nonsurgically and went on to fracture union without MCS widening [35].

Recently, Gougoulias and Sakellariou [38] published an overview of the different types of radiograph and confirm our statement concerning the importance of the integrity of the deep deltoid ligament in identifying stability of the ankle. They propose a further division in ligamentous SER-type IV fractures, potentially unstable, with a ruptured anterior tibiotalar ligament (ATTL), but an intact posterior tibiotalar ligament (PTTL). They recommend that these fractures, with even a 50% ruptured deep deltoid ligament, could be treated safely with immobilisation in a cast. Further prospective research is needed to clarify this issue further.

In addition to the beneficial results, this study also has some limitations. It has been reported that MRI is not a 100% accurate predictor of ligament disruption [39, 40]. As written above, the gold standard is a surgical (open or arthroscopic) exploration of the ankle. Still, MRI has been found to be highly sensitive and specific for diagnosing traumatic ligament injury and is currently the best available non-invasive comparative radiographic test [8–10].

Furthermore, theoretically a complete joint dislocation during the gravity stress test could lead to nerve palsy or compartment syndrome. In our centre, however, we have experienced no such complications yet and there has been no description in the literature concerning these problems either.

Moreover, the number of totally ruptured DDL's in this patient cohort is quite limited. This is due to the choice we made to exclude patients with a MCS widening of ≥ 6 mm on the conventional mortise view, because they were immediately planned for operative treatment.

In conclusion, gravity stress radiographs have additional value in detecting a complete rupture of the DDL in addition to the conventional mortise view. It can be regarded as a safe, fast, and beneficial method to make an accurate distinction between stable and unstable isolated Weber B ankle fractures without using MRI.

Compliance with ethical standards

Conflict of interest C.A.T. van Leeuwen, T. Haak, M.P.M Kop, N.L. Weil, F.M. Zijta and J.M Hoogendoorn declare that they have no conflict of interest.

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