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The diagnosis and treatment of isolated type B fibular fractures: Results of a nationwide survey

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ABSTRACT

Introduction: In isolated Weber B fractures (type B fibular fractures), ruling out instability is critical for safe conservative treatment. In fractures without evident medial injury, additional diagnostics like MRI scan or gravity stress test should be done to differentiate between a stable and unstable fracture. The aim of the current study is to gain more insight in current practice and treatment of type B fractures by Dutch trauma- and orthopaedic surgeons.

Materials & methods: In December 2017 and January 2018, 559 trauma surgeons were invited by email to join an online survey. This survey consisted of questions regarding diagnostics and treatment of isolated distal fibula fractures. Also, respondents were asked to state their preferred treatment of eight separate cases.

Results: In total, 161 surgeons participated, covering 68 different hospitals in the Netherlands. Of them, 32.0% treat more than 30 ankle fractures a year. Based on regular mortise radiographs, 13.6% of the respondents chose surgical treatment in case of a medial clear space (MCS) > 4 mm, 33.8% in case of a MCS > 6 mm and 45.5% in case of a MCS > 4 mm in addition to the MCS ≥ superior clear space + 1 mm. Moreover, 18.2% make use of additional diagnostics (43.9% repeat mortise view after a week, 16.6% weight bearing radiograph, 8.6% gravity stress view, 7.9% exorotation radiograph, 6.5% MRI scan, 0.7% ultrasound, 16.8% other) and 8% establishes their decision not based on the mortise radiograph. Fibular dislocation of ≥ 2 mm was used as an indication for surgical treatment by 69%. Of them, 56% decides to treat surgically in these cases, even with proven medial stability.

Conclusion: Many surgeons treat type B fibular fractures with a MCS > 4 mm at mortise view surgically, even without proven medial injury. Rarely, additional diagnostics as MRI or gravity stress test are performed in cases with a MCS 4–6 mm. Consequently many stable ankle fractures are treated operatively unnecessarily.

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Introduction

Treatment of B-type ankle fractures, with its fibular fracture at the level of the syndesmosis, depends on stability of the ankle joint. Fractures without medial injury (Lauge-Hansen supination-exorotation (SER) type 2 injury) are considered stable and therefore conservative treatment is recommended [1–5]. In case of an additional medial fracture or a rupture of the deep deltoid ligament (SER type 4 injury), the fracture is considered unstable and generally operative treatment is recommended [6]. Therefore the accurate diagnosis of medial injury, is of great clinical importance.

Lateral and mortise X-ray views of the ankle are generally performed if an ankle fracture is suspected. A fracture of the medial malleolus is usually clearly visible, however medial ligamentous injury can be more difficult to diagnose. Generally, the medial clear space (MCS) is used to diagnose deep deltoid ligamentous injury. However, the cut-off value for a widened MCS has been subject to debate [7,8].In many hospitals, B-type fibular fractures with a MCS > 4 mm are treated operatively, despite a lack of evidence supporting this treatment [9,10]. Consequently, this might lead to surgical overtreatment of stable fractures. Therefore, the recently published Dutch guideline 'Ankle fractures' only advises operative treatment in case of a medial fracture or MCS > 6 mm. In

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cases of uncertain medial integrity additional diagnostics like the weight bearing radiograph [11–13], ultrasound [14,15]or MRI [16,17]should be considered to exclude instability. If no instability is proven, the guideline advises conservative treatment [5].

The aim of this study is to examine the current use of diagnostics tools and treatment of B-type fractures among Dutch trauma surgeons. Additionally we evaluated whether this current common practice is in concordance with the Dutch guideline 'Ankle fractures'.

Materials & methods

Study design

For this cross-sectional study, an online Dutch survey was developed. Its questions were partly derived from recent literature. The survey was sent to 559 traumasurgeons, Orthopedic surgeons and residents from both specialties in 68 different Dutch hospitals (contrary to most other countries in the Netherlands both traumasurgeons and Orthopedic surgeons treat musculoskeletal trauma). The survey consisted of 4 personal demographic questions, 6 diagnostic related questions, 5 treatment related questions, 16 example cases and 3 questions about awareness of current guidelines. The cases provide patient characteristics and fracture radiographs, asking the surgeon to decide treatment. Moreover, additional diagnostics that were used were included in a following question, asking whether these additional examinations influence their treatment decision. All questions included in the survey are shown in Table 1. In the survey, for some questions it was possible to agree with multiple answers, resulting in a total response of more than 100%. The radiographs of the example cases are shown in the Appendix.

Data were collected using SurveyMonkey (http://www.surveymonkey.com): an online data collection program.

Analysis

All data gathered from the online database were stated as frequencies and percentages.

Results

Surgeon characteristics

In total 178 (161 surgeons; 17 residents) recipients from 68 different hospitals returned the questionnaire (response rate 32%). Of these 77.1% had more than 10 years of experience treating ankle fractures. This differentiation is shown in Graph 1 . The majority (82.6%) treated more than 10 ankle fractures a year, of whom 32.0% treated more than 30 ankle fractures a year.

Treatment characteristics

Of the surgeons, 13.6% stated to treat ankle fractures with MCS > 4 mm at regular mortise radiographs surgically, and 33.8% in case of a MCS > 6 mm without any additional information about medial ligamentous injury (question 5). Almost half (45.5%) chose surgery in case of MCS > 4 mm and MCS ≥ superior clear space (SCS) + 1 mm. Moreover, 18% made use of additional diagnostics (43.8% repeat the mortise view (in cast) after one week, 15.9% CT scan, 16.6% weight bearing view, 8.6% gravity stress view, 7.9% exorotation radiograph, 6.5% MRI scan, 0.7% ultrasound) and 8% established their decision not based on the mortise radiograph. Table 1 shows all results. In Graph 2 , a subdivision based on years of experience is made between surgeons, comparing their criteria to treat surgically.

A total of 90.9% of the surgeons declared fibular displacement critical in determining treatment. Regardless of medial injury, more than half of the surgeons (53.7%) allow a maximum of 2 mm lateral displacement with conservative treatment. On the lateral radiograph over 2 mm of fibular displacement led to surgical treatment by 69.1% of the surgeons, while 20.6% allow 3 mm and 6.6% allow 4 mm displacement. 14.7% do not use displacement on the lateral radiograph as a critical measurement in their treatment decision.

Furthermore, conservative treatment differs between the respondents. A stable B-type fracture in a healthy adult is treated with a cast (mean duration of 5 weeks) by 85.1% of the surgeons, with a walker by 6.0% and with a brace by 1.4%. The remaining 7.5% vary treatment depending on patients' characteristics and preference; often starting off with a cast for three weeks followed by a brace for a few more weeks.

Surgical after-treatment consists of direct non-weightbearing mobilization of the ankle (29.1%); non-weightbearing plaster for two weeks, followed by non-weightbearing mobilization (26.4%) or non-weightbearing plaster for two weeks, followed by a walking cast (23.0%). Unprotected weightbearing after two weeks in a non-weightbearing plaster is allowed by 3.4% of the surgeons; while 3.4% allow direct postoperative weightbearing without any form of immobilization.

It is noticeable that 58.4% of the surgeons was acquainted with the Dutch guideline 'Ankle fractures'. In 30.6% of the surgeons, the guideline did influence their diagnosis and treatment.

To illustrate, 56.9% of the respondents would treat the ankle fracture in case 1 of the Appendix surgically; 25.3% nonoperative; while the remaining 17.8% would use additional diagnostics. With the additional information of the gravity stress view in the next question 54.8% would treat surgically while 45.2% of the surgeons choose nonoperative treatment.

Opinions on surgical versus nonsurgical treatment of case 3 is divided in 43.7% versus 35.9% respectively, with the other 20.4% using additional diagnostics. Adding the weightbearing radiographs, 79.6% would treat conservatively.

Discussion

The aim of this study was to assess the variation in current use of diagnostics and management of type B fibular fractures among surgeons in the Netherlands.

Of the survey respondents, 13.6% stated to treat ankle fractures with MCS > 4 mm at regular mortise radiographs surgically, and 33.8% in case of a MCS > 6 mm without any additional information about medial ligamentous injury. Moreover, 18% made use of additional diagnostics (43.8% repeat the mortise view (in cast) after one week, 15.9% CT scan, 16.6% weight bearing view, 8.6% gravity stress view, 7.9% exorotation radiograph, 6.5% MRI scan, 0.7% ultrasound) and 8% established their decision not based on the mortise radiograph

A total of 90.9% of the surgeons declared fibular displacement critical in determining treatment and 58.4% of the surgeons was acquainted with the Dutch guideline 'Ankle fractures'.

In general, stable fractures can safely be treated conservatively, while for unstable fractures surgical treatment is advised. Therefore, it is important to differentiate accurately between stable and unstable ankle fractures. In stable fractures, functional outcome after surgical stabilization is not superior to nonsurgical treatment. Moreover, surgery is associated with significant costs and possible complications [2,9,18,19].

To evaluate stability of ankle fractures additional diagnostics like ultrasound, MRI scan or loaded stress test can be used. The MRI scan has met most requirements to distinguish between a stable and unstable ankle fracture, with a proven sensitivity of 80% and a

Table 1
online survey, translated from Dutch to English.

Survey Questions	
1. Number of years of work experience, including (prior) education	
a. 0-5	6,2%
b. 6-10	16,2%
c. 11-15	35,8%
d. 16 years or more	41,9%
2. What is your medical speciality	
a. Trauma surgeon	40,5%
b. Orthopaedic surgeon	50,0%
c. General surgery resident	0,6%
d. Orhopaedic surgery resident	9,0%
3. In which hospital are you currently employed? 68 different hospitals	
4. How many ankle fractures do you treat approximately in one year?	
a. 0-10	17.4%
b. 11-20	32.6%
c. 21-30	18.0%
d. 30 or more	32.0%
5. What MCS cut-value is an indication for surgery for you in a healthy middle aged patient? (multiple answers possible)	
a. MCS > 4 mm	13.6%
b. MCS > 4 mm and MCS > superior clear space (SCS) + 1 mm	45.5%
c. MCS > 6 mm	15.6%
d. MCS > 6 mm; conduct additional diagnostics between MCS 4-6 mm	13.6%
e. MCS > 6 mm; conduct additional diagnostics b	4.6%
f. Otherwise (open field)	22.7%
6. In case you have chosen to conduct additional diagnostics, which one do you use? (multiple answers possible)	
a. Repeat the mortise view after 1 week (in cast)	43.9%
b. Gravity stress view	8.6%
c. Weight bearing view (without cast)	16.6%
d. Exorotation test	7.9%
e. MRI	6.5%
f. Ultrasound	0.7%
g. Does not apply	19.4%
h. Other diagnostic (open field)	20.9%
7. Does fibula dislocation play a role for you in your decision to treat conservatively or surgically?	
a. Yes	90.9%
b. No	9.1%
8. What value of the anterior-posterior fibula dislocation do you accept in treating conservatively?	
a. 2 mm	53.7%
b. 3mm	20.6%
c. 4 mm	6.6%
d. Does not apply	0.00%
e. Otherwise (open field)	19.1%
9. What value of the lateral fibula dislocation do you accept at the regular mortise view?	
a. 2 mm	69.1%
b. 3mm	11.8%
c. 4 mm	4.4%
d. Otherwise (open field)	14.7%
10. Do you prefer surgery when the fibula dislocation is your maximum value (question 8-9) in combination with a congruent anke joint?	
a. Yes	56.0%
b. No	44.0%
11. How do you conservatively treat stable Weber B fractures in healthy patients?	
a. Cast	85.1%
b. Brace	1.4%
c. Walker	6.1%
d. Otherwise (open field)	7.4%
12. How many weeks do you tell the patient to wear the cast, the brace or the walker? Mean 5 weeks	
13. After how many weeks do you allow the patient to walk (weight bearing)? Mean 3 weeks	
14. How do you start this weight bearing programme from the start?	
a. A constructive scheme in 4-6 weeks	27.7%
b. Direct guided by pain	68.2%
c. Otherwise	4.1%
15. How do you treat an isolated Weber B fracture post surgery?	
a Cast for 2 weeks; followed by non weight bearing mobilization in case of normal wound healing	26.4%
b. Cast for 2 weeks; followed by walking cast in case of normal wound healing	23.0%
c. Cast for 2 weeks; followed by direct weight bearing mobilization, without cast	3.4%
d. Post operative pressure bandage and direct weight bearing mobilization guided by pain	3.4%
e. Post operative pressure bandage and direct non weight bearing mobilization	29.1%
f. Otherwise	19.6%
Questions 16-31 cases example questions	
32. Do you use a local of regional protocol for the treatment of isolated Weber B fractures?	
a. Yes	62.8%
b. No	30.0%
c. Otherwise	7.3%
33. Do you know the current Dutch protocol' 'Richtlijn Enkelfracturen 2017''?	
a. Yes	58.4%
b. No	41.6%
34. If you are aware of this protocol; does this influence your treatment?	
a. No	69.4%
b. Yes	30.6%

specificity of 100% with surgical exploration as a reference [16,17]. Disadvantages are its high costs and limited availability.

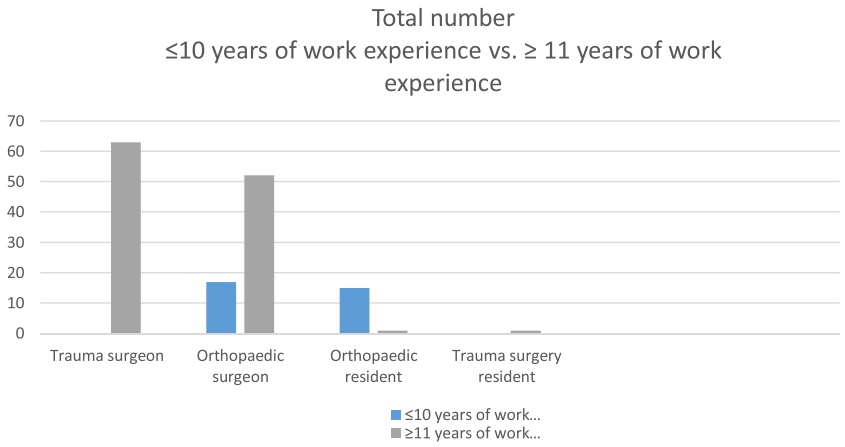
Two studies reported 100% specificity and sensitivity for detecting a rupture of the deep deltoid ligament with ultrasound [14,15]. However, the number of patients in these studies was very small. Disadvantage is the fact that it is an operator-dependent examination.

Another radiographic tool is the manual stress radiograph in which the tibia is internally rotated to obtain a mortise view. This is followed by manual dorsiflexion and external rotation of the foot [20]. McConnel et al. studied the stress radiograph and found a significant difference in MCS from 3.63 mm in stable fractures vs. 5.69 mm in instable fractures ($p < 0.0001$) [21].

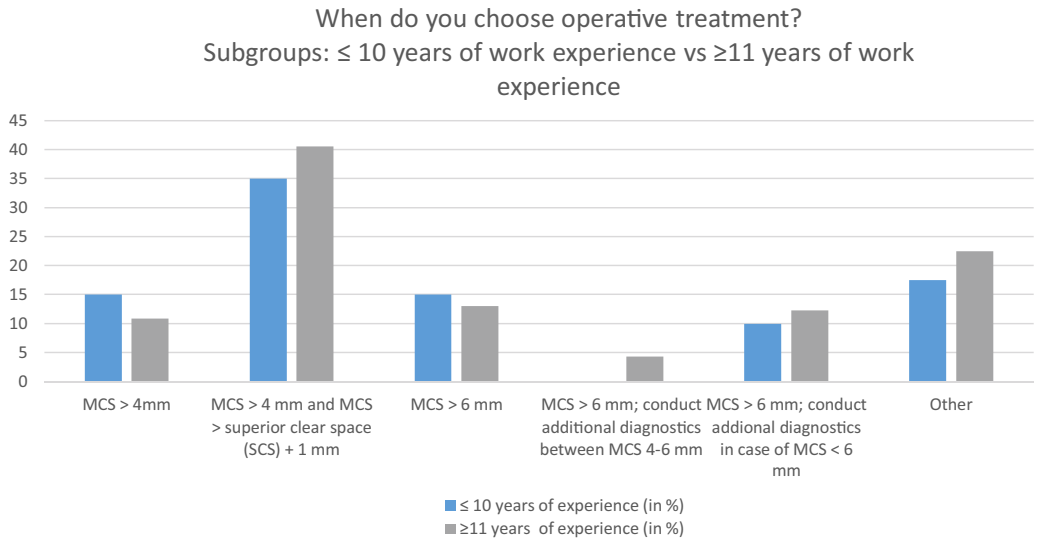
Compared with the gravity stress radiograph the manual stress radiograph was equivalent in determining deltoid injury (mean MCS were 5.21 and 5.00 mm ($p = 0.69$) on the manual and gravity stress radiographs, respectively). Disadvantages include the fact that the amount of force applied is not standardized and that it is considered a painful examination [22].

During the gravity stress test the patient lies down horizontally with the medial side of the ankle up. The ankle and foot are free of any external support. The MCS widens if a complete deltoid rupture is present. Gill [22] and Schock [23] compared the external rotation test with the gravity stress radiograph. The MCS did not differ significantly between the gravity stress test and the external rotation test in these studies. The gravity stress test was, however, experienced less painful than the external rotation test. Another recently published study showed that compared to MRI, the gravity stress radiograph (with a threshold of MCS $\geq$ 6 mm) has a sensitivity of 100 and specificity of 91.7 in detecting deep deltoid rupture [24].

Another diagnostic option is the weightbearing stress test. Within ten days after the initial trauma a barefoot weightbearing mortise radiograph is made to judge the MCS. Weber et al. found that in 90% of their cohort the fracture was considered stable based on the weightbearing radiograph and showed a mean AOFAS ankle-hindfoot score of 96.1 (range 86–100) with a mean follow-up of 5.2 years after conservative treatment [11]. Hoshino et al. investigated the weightbearing radiograph as well and demonstrated a mean AOFAS score of 92 at final follow-up (at 12 months)of



Graph 1. Total number of surgeons subdivided into years of experience.



Graph 2. Criteria used for operative treatment; subdivided into years of experience.

conservatively treated patients [12] Hastie et al. studied the treatment of undisplaced malleolar fractures of uncertain stability in functional braces using weightbearing radiographs to judge stability. They found a risk of displacement of 0% thus providing support for the use of weightbearing radiographs to guide treatment of undisplaced ankle fractures [13]. Holmes et al. concluded that weightbearing radiographs are predictive of stability in Weber B ankle fractures. Their cohort was treated nonsurgically in case of a normal mortise relationship on weightbearing radiographs in addition to MCS < 7 mm on gravity stress radiographs and showed a mean AOFAS of 92.3 and no MCS widening on subsequent weightbearing radiographs at 1 year follow-up [25]. One disadvantage of this radiograph is that because of the height of the x-ray tube, it is in some hospitals practically not possible to perform this radiograph without the patient standing on a little step. This can be a difficult exercise especially in elderly patients with a recent fracture.

Our results show that almost half of the respondents treat ankle fractures with MCS > 4 mm or MCS > SCS + 1 mm surgically without information on the integrity of the deltoid ligament. Recent literature has shown that in a fibular fracture with MCS > 6 mm, the deltoid ligament is still intact in 9% [26]. This percentage will increase with MCS 4–6 mm. Surgical treatment might cause complications [18] and is costly. In the Netherlands a conservatively treated ankle fracture costs approximately 400 euros, compared to 3500 euros for surgical treatment; this amount lies between American and English costs [27,28]

In the cohort of this study, only a fifth of the surgeons perform one of the additional diagnostic tests in case of MCS 4–6 mm. Of them, 43.9% repeat the mortise view one week after trauma, followed by the weight bearing test (16.6%) and the gravity stress test (8.6%). Only 6.5% of the surgeons make use of the MRI scan as additional tool.

Of the respondents, 90.9% do use fibular displacement as a critical determinant in the decision-making process. Of them 53.7% treat surgically with more than 2 mm lateral fibular displacement even if there is no high suspicion of medial injury. However, in isolated distal fibular fractures, the degree of fibular displacement is not directly associated with tibiotalar incongruity and ankle instability [29–31]. Hence, it has been proven that stable ankle fractures can safely be treated non-operatively with fibular displacement up to 5 mm [32–36].

It is, thus, very noticeable that, without support for this in literature, 90.9% of the surgeons do use fibular displacement as a determinant in their treatment decision.

When treating ankle fractures nonoperatively, the majority of the surgeons choose cast as primary choice of treatment and only a very small percentage makes use of a brace. Known disadvantages of casting are joint stiffness, muscle wasting, lack of comfort, risk of thromboembolism and skin problems [37,38].

Compared to a cast, a brace or elastic support have proven to be more comfortable options for treating stable type B ankle fractures [39–41].

We are aware that our study has several limitations. Despite many reminder emails, the response rate is still quite low (32%). Next to the low response rate, this study represents only a national cohort. However, to our knowledge, the Dutch standard of care is not substantially different from care in other high-developed countries and therefore we expect these results to be representative internationally.

Also, the guideline was published online in July 2017. The survey was sent to the surgeons in December of 2017. This relative short interval might have led to the guideline not being implemented in local hospitals yet as evidenced by the fact that just over half of the respondents was acquainted with the guideline. It would be interesting to repeat this study in a few years.

This is the first study to investigate the current use of additional diagnostics in excluding medial instability in a subset of ankle fractures. This nationwide survey investigates the treatment of a common fracture. In our country, with a high standard of care, surgeons do not make use of the latest insights in diagnostics and treatment. They make limited use of the guideline based on these insights.

Conclusion

This study demonstrates the lack of uniform diagnostic and treatment strategies for type B ankle fractures. Despite the recent availability of a national guideline, common practice of Dutch surgeons has not changed accordingly. This leads to surgical overtreatment of stable type B ankle fractures with associated complications and costs.

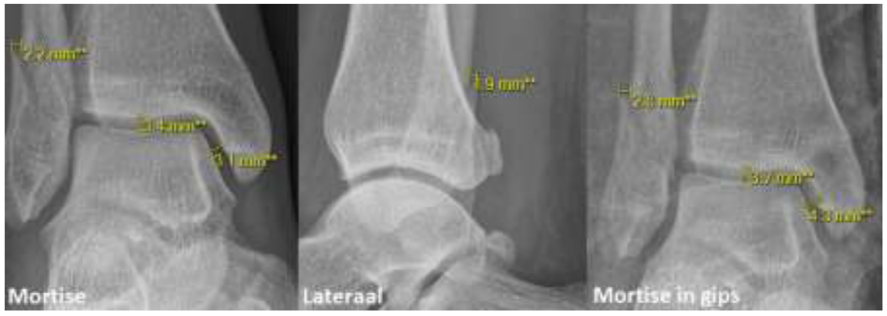
Conflict of interest

All authors declare that they do not have any conflict of interests.

Appendix A

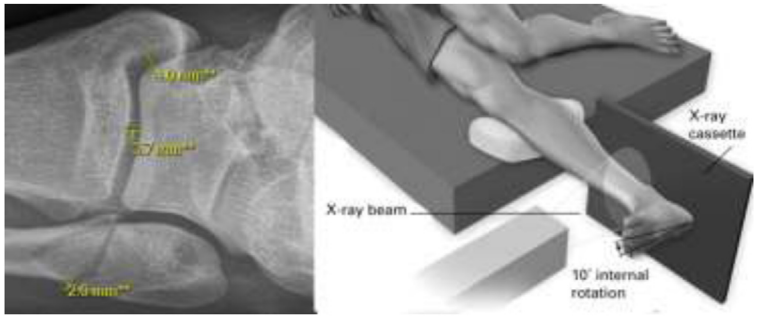
Cases example questions

Case 1



16. How would you treat this ankle fracture of a 20 years old healthy man?

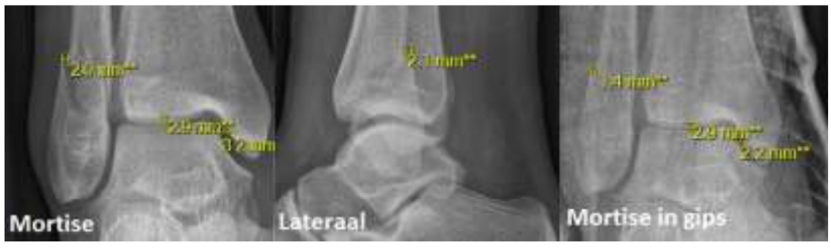
a.	Operative	56.9%
b.	Conservative	25.3%
c.	The additional diagnostics chosen in question 6	17.8%



17. How would you treat this fracture with the additional information of this gravity stress view?

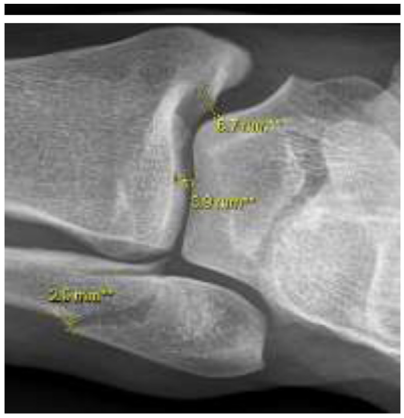
a.	Conservative	45.2%
b.	Operative	54.8%

Case 2



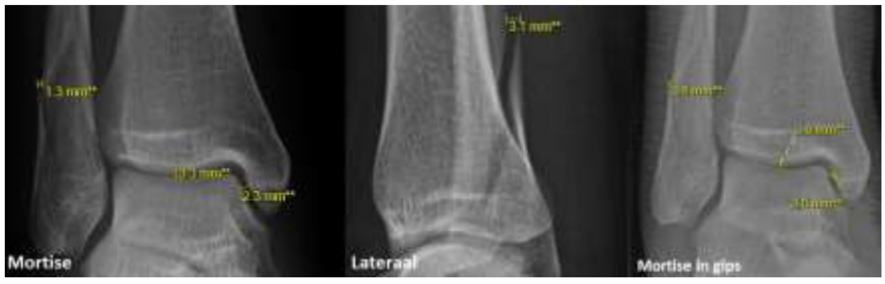
(*Continued*)

Cases example questions	
18. How would you treat this ankle fracture of a 26 years old healthy woman?	
a. Operative	49.0%
b. Conservative	30.8%
c. The additional diagnostics chosen in question 6	20.3%

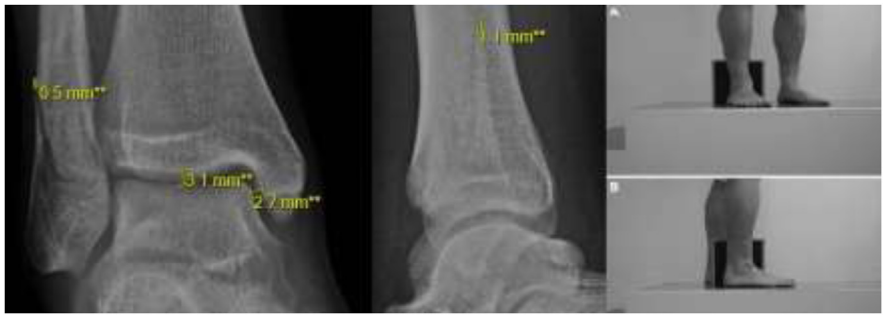


19. How would you treat this fracture with the additional information of this gravity stress view?	
a. Conservative	8.5%
b. Operative	88.6%
c. Otherwise	2.8%

Case 3

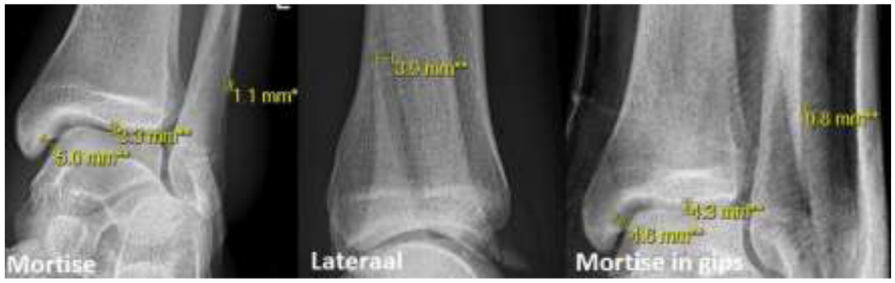


20. How would you treat this ankle fracture of a 23 years old healthy woman?	
a. Operative	43.7%
b. Conservative	35.9%
c. The additional diagnostics chosen in question 6	20.4%

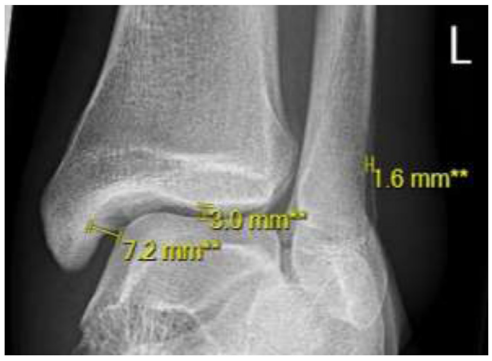


21. How would you treat this fracture with the additional information of this weight-bearing view?
    a. Conservative 79.6%
    b. Operative 20.4%

Case 4

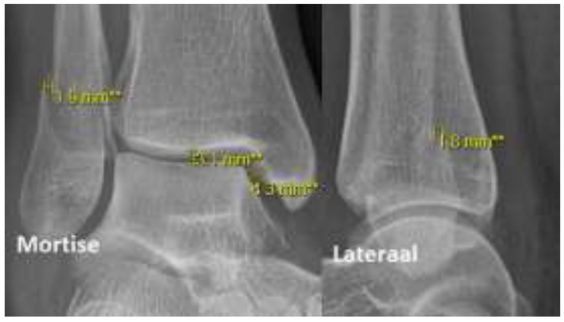


20. How would you treat this ankle fracture of a 23 years old healthy woman?
    a. Operative 83.2%
    b. Conservative 4.9%
    c. The additional diagnostics chosen in question 6 11.9%

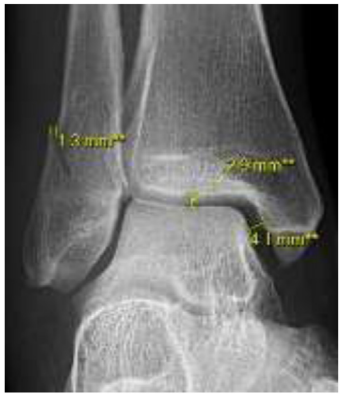


23. How would you treat this fracture with the additional information of this weight-bearing view?
    a. Conservative 0.7%
    b. Operative 99.3%

Cases 5



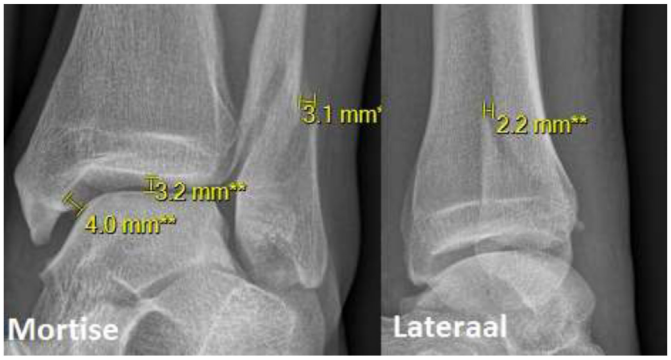
24. How would you treat this ankle fracture of a 56 years old healthy man?
    a. Operative 70.6%
    b. Conservative 9.1%
    c. The additional diagnostics chosen in question 6 20.3%



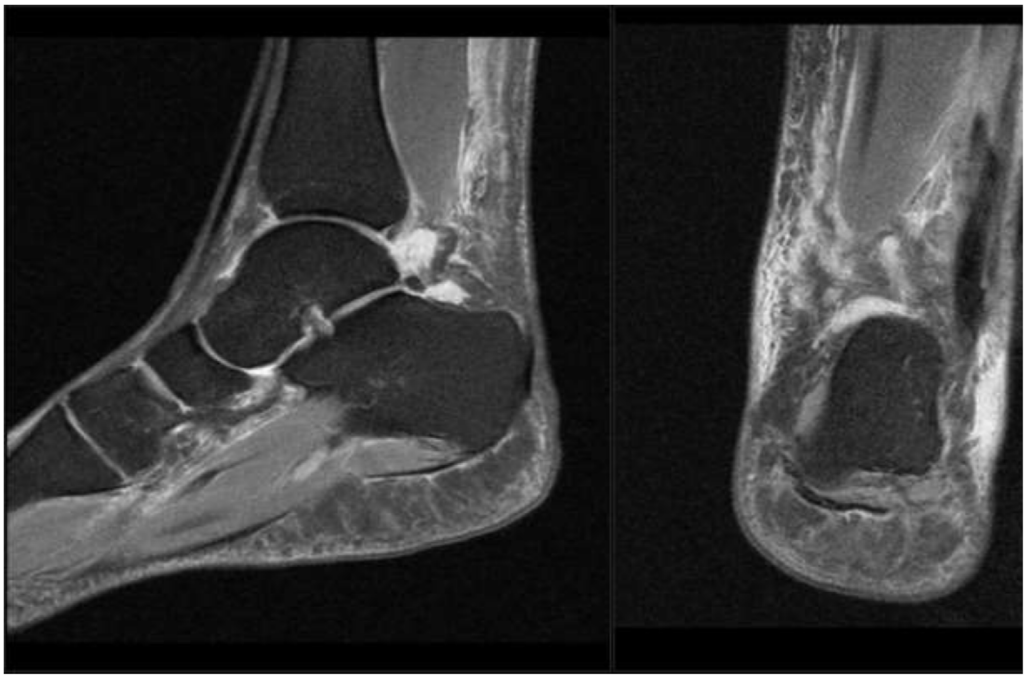
(*Continued*)

Cases example questions	
25. How would you treat this fracture with the additional information of this weight-bearing view?	
a. Conservative	39.4%
b. Operative	60.6%

Case 6

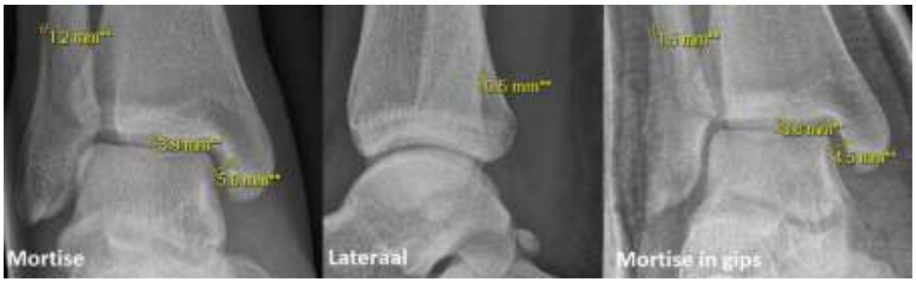


26. How would you treat this ankle fracture of a 45 years old healthy woman?	
a. Operative	87.2%
b. Conservative	3.6%
c. The additional diagnostics chosen in question 6	9.2%

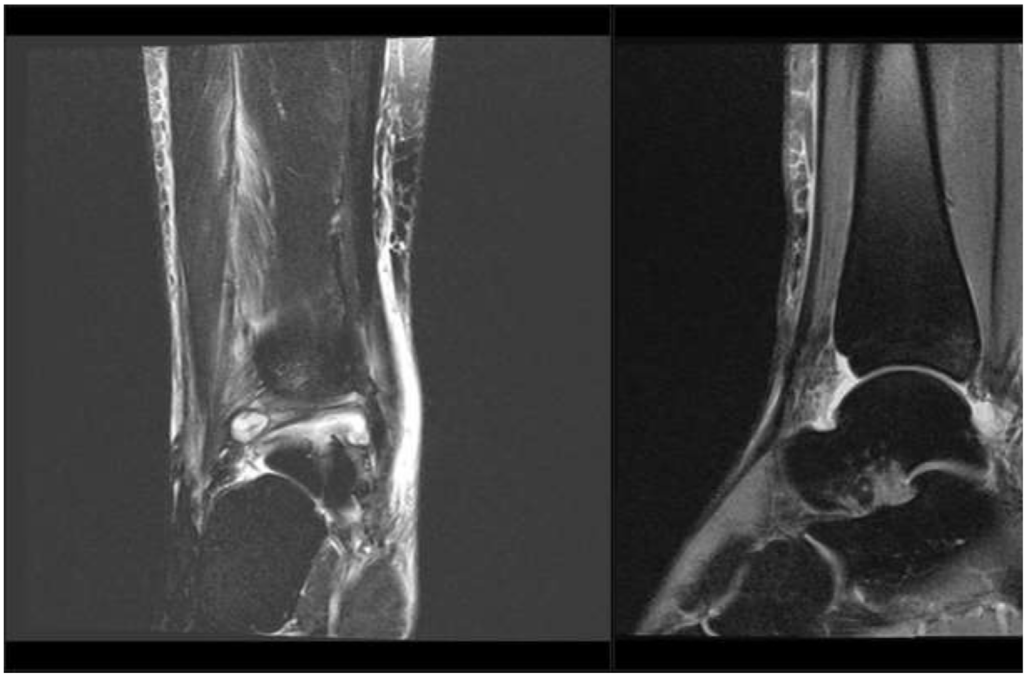


27 An MRI was made within a week, showing a fracture of the distal fibula, with the medial malleolus and malleolus tertius intact with a rupture of the deep ligament deltoid. How would you treat this fracture after having seen the additional MRI scan?	
a. Conservative	12.1%
b. Operative	87.9%

Case 7

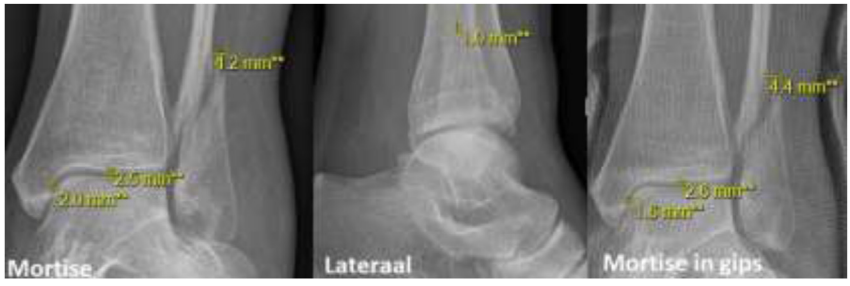


28. How would you treat this ankle fracture of a 35 years old healthy man?
    a. Operative 25.00%
    b. Conservative 47.8%
    c. The additional diagnostics chosen in question 6 27.2%



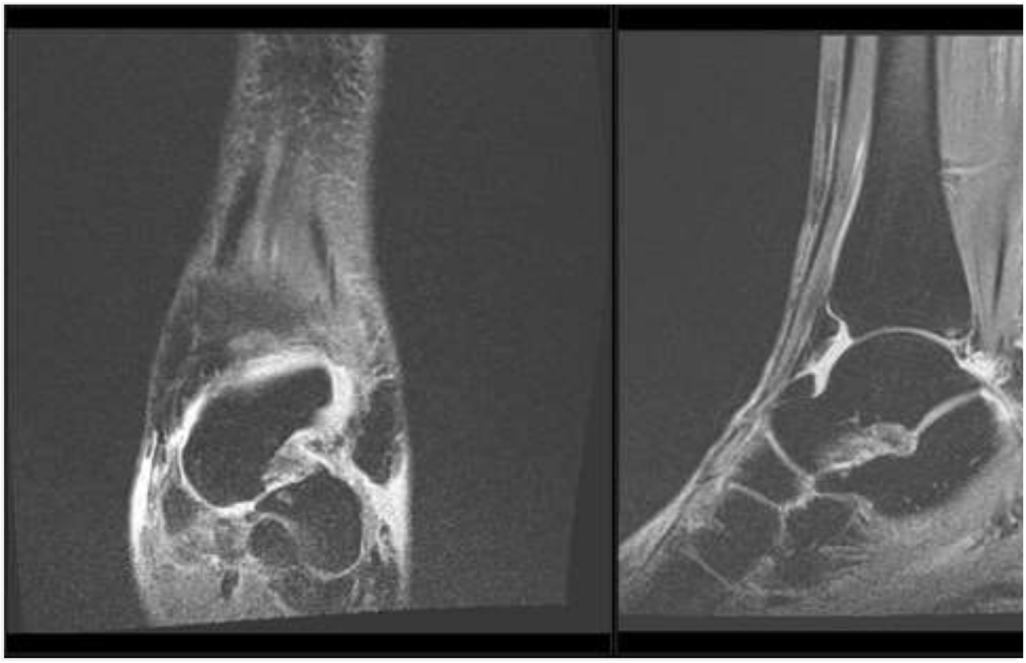
29 An MRI was made within a week, showing a fracture of the distal fibula, with the medial malleolus and malleolus tertius intact without a rupture of the deep ligament deltoid. How would you treat this fracture after having seen the additional MRI scan?
    a. Conservative 82.6%
    b. Operative 17.4%

Case 8



(*Continued*)

Cases example questions		
30	How would you treat this ankle fracture of a 45 years old healthy man?	
	a. Operative	74.5%
	b. Conservative	13.9%
	c. The additional diagnostics chosen in question 6	11.7%



31	An MRI was made within a week, showing a fracture of the distal fibula with the medial malleolus and malleolus tertius intact without rupture of the deep ligament deltoid. How would you treat this fracture after having seen the additional MRI scan?	
	a. Conservative	32.4%
	b. Operative	67.7%

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