Validation of the Ottawa ankle rules in a Danish emergency department

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ABSTRACT

INTRODUCTION: The Ottawa ankle rules (OAR) is a tool physicians may use to determine whether or not to perform an x-ray after an ankle or midfoot distortion or blunt trauma to these structures. The rationale of using the OAR is to exclude a fracture by means of clinical examination without resort to x-rays, and thereby limiting the use of x-rays, time, costs, etc. The principle of the OAR is that an ankle x-ray is only required when there is bone tenderness along the distal six centimetres of the posterior part of the medial or lateral malleolus, or when the patient is unable to bear weight immediately after the accident and in the emergency department (ED). Similarly, an x-ray of the midfoot is required only when there is bone tenderness at the base of the 5th metatarsal or the navicular bone, or when the patient is unable to bear weight immediately after the accident and also in the ED. Our hypothesis was that by introducing the OAR, we would reduce the use of x-rays without increasing the number of missed fractures.

MATERIAL AND METHODS: The study was designed as an intervention study with 882 patients in the control group and 1,014 patients in the intervention group. The intervention consisted of several OAR implementation measures.

RESULTS: Before use of the OAR, 62% had an x-ray taken. This proportion was reduced to 57% with the introduction of the OAR. We registered a significant reduction ($p < 0.001$) in x-ray without increasing the number of missed fractures.

CONCLUSION: The OAR may reduce the number of x-rays and possibly also save costs and time if implemented in Denmark.

Ankle and foot injuries are very common in any emergency department (ED). The majority of patients undergo plain radiography to rule out fractures, which causes a significant drain on radiographic resources [1]. Less than 15% of the patients examined without the use of the OAR who had an x-ray of the ankle or midfoot actually had a fracture [1]. To reduce the number of unnecessary ankle and midfoot radiographs, Stiell et al from the University of Ottawa and the Ontario Ministry of Health developed a set of clinical decision rules called the Ottawa ankle rules (OAR) [2]. The rationale of using the OAR is to exclude fractures simply on the basis of a thorough examination. If certain criteria are met, an x-ray becomes unnecessary. The OAR was tested in a wide range of clinical settings, and most studies report a high sensitivity (nearly 100%) in detecting significant fractures. However, some have reported lower sensitivities [1, 3], and Lucchesi et al and Kelly et al found unacceptably low sensitivities of 94.6% and 93%, respectively [4, 5]. Implementation of the OAR in a Danish setting has never been documented, and documentation is required to issue a general recommendation. The introduction of novel diagnostic procedures in new clinical settings and cultures requires considerable caution, because values such as sensitivity and specificity may change significantly in such a situation. The reasons for this are plenty and it is difficult to predict the clinical outcome without testing the diagnostic procedure in the local setting. Some procedures can easily be adopted, but others are more complex and may influence results. Such procedures need to be tested first.

The purpose of this study was to provide evidence about the use of the OAR as a method for prediction of significant fractures in a Danish clinical setting. We wanted to test the OAR used in other countries in our ED. Our hypothesis was that introduction of the OAR would significantly reduce the number of x-rays without increasing the number of missed fractures.

This study is a clinical intervention study performed at the ED at Kolding Hospital, which is a rural Danish hospital with 300 beds. The intervention and control groups comprised all patients presenting with a blunt trauma to the ankle during a period of 12 months.

MATERIAL AND METHODS

We included all patients admitted to the ED at Kolding Hospital with an acute blunt ankle or midfoot injury sustained from 1 September 2006 to 31 August 2007. All ages were included and no patients were excluded. The original OAR excluded children, but it has since been shown that the OAR can be used in children as well [6-8]. The patients who presented during the initial six months were included in the control group; those presenting during the subsequent six months formed the intervention group. The junior physicians diagnosing

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patients in the control group period moved to other departments after the six-month period as part of their internship. The intervention consisted of a 30-minute introduction to the OAR imparted by the principal investigator (RK). It was given to the new group of junior doctors starting in the emergency department. The intervention included junior doctors only, and neither the junior nor the more senior doctors knew that they were participants in a formalised study. All junior doctors had less than one year of clinical experience. Flyers and posters were distributed. After four weeks most of the new doctors were reminded about the OAR at a 5-minute meeting. The study comprised no other interventions or reminders. We did not register physicians' compliance in using the OAR.

The rationale of the OAR is that in many situations a thorough examination can exclude a fracture in the ankle or midfoot. An x-ray of the ankle is only required when symptoms include bone tenderness along the distal six centimetres of the posterior medial or lateral malleolus, or when the patient is unable to bear weight both immediately after the accident and in the ED. In the same way, an x-ray of the midfoot is only required when there is bone tenderness at the base of the 5th metatarsal or the navicular bone, or when the patient is unable to bear weight both immediately after the accident and in the ED. See **Figure 1** for details.

Patients were given oral instructions and encouraged to seek re-examination by a physician in five to seven days if their pain and their ability to walk did not improve. In addition, clinical judgement should prevail over the rules if the patient:

- was intoxicated or uncooperative
- had other distracting painful injuries
- had diminished sensation in the legs
- had gross swelling preventing palpation of the malleolar bone tenderness.

We consistently collected data by reviewing the patients' electronic files including data from our hospital and all hospitals within a radius of 70 km. We noted if they returned, especially if no x-ray had been taken initially, and why patients had returned. We defined "no significant fracture" as:

a) Normal x-ray (taken initially or if the patient returned) or
b) No initial x-ray was taken AND the patient had not returned within 12 months to any of the hospitals in our database.

When a fracture was diagnosed after the initial assessment, we defined a "significant fracture" as a fracture requiring more than the usual treatment for a sprained ankle (soft bandage, elevation, ice, etc.)

The two groups were analysed separately (**Table 1**). Statistical comparison using Fisher´s exact test revealed no significant difference between the two groups, apart from the values marked with *.

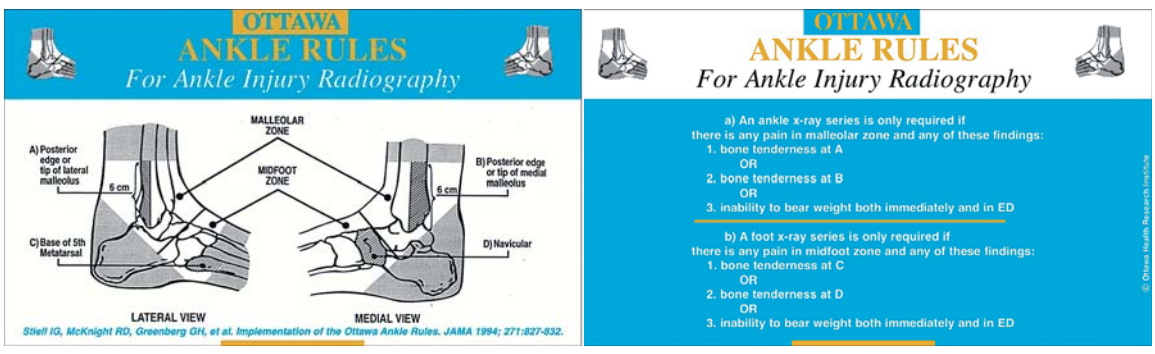
The main outcomes were OAR sensitivity and specificity, how many fractures were missed in the two groups, and how many had an x-ray taken.

Statistical analysis: Comparison of patient characteristics and other outcomes were tested with Pearson one tailed χ^2-test, with a significance level of 0.05. We used Intercooled Stata v. 8.0, Stata Corporation for our calculations.

RESULTS

The overall proportion of patients referred for ankle radiography was 61.9% in the control group and 57.2% in the intervention group ($p < 0.001$). The pre-OAR examination techniques in the control group had a sensitivity of 0.969 and the use of the OAR had a sensitivity of 0.988 ($p < 0.05$, 95% confidence interval ± 4.3%). **Table 2** shows how many x-rays were preformed in the two groups and which regions were

FIGURE 1



Ottawa ankle rules for ankle injury radiography. Reprinted with permission from Ottawa Health Research Institute, The Ottawa Hospital, Ottawa.

TABLE 1

Patient data of the control and intervention group.

	Control group (first six months)	Intervention group (Last six months)
Patients, n	882	1.014
Gender, % male/female	51.5/48.5	52.5/47.5
Age, years, average/median	28.3/24	26.5/21*
Age, n (%)		
< 20 years	384 (43.6)	501 (49.4)*
21-40 years	299 (33.9)	294 (29.0)*
41-60 years	140 (15.8)	161 (15.8)
> 60 years	59 (6.7)	58 (5.7)
Patients without a fracture who came back for reassessment, n (%)	26 (3.4)	30 (3.5)
Treatment, n (%)		
Conservative	111 (87.4)	145 (83.3)
Operative	16 (12.6)	29 (16.7)

*) Significant difference ($p < 0.05$) between intervention- and control group

TABLE 2

Number of x-rays by which fractures were diagnosed.

	Control group (first six months)	Intervention group (last six months)
X-rays performed, n (%)		
Total	546 (61.9)*	581 (57.2)*
Ankle	402 (73.6)	431 (74.2)
Midfoot	99 (18.2)	106 (18.2)
5th metatars	13 (2.3)	17 (2.9)
Ankle & midfoot	24 (4.4)	23 (4.0)
Ankle & 5th metatars	7 (1.3)	3 (0.5)
Midfoot & 5th metatars	1 (0.2)	1 (0.2)
Type of fractures, n (%)		
Total	127 (14.4)	174 (17.1)
Lateral malleolus	51 (40.2)	57 (32.8)
Medial malleolus	6 (4.7)	12 (6.9)
Posterior malleolus	12 (9.4)	10 (5.7)
Bimalleolar	5 (4.1)	4 (2.3)
Trimalleolar	4 (3.1)	9 (5.2)
Talus	2 (1.6)	1 (0.6)
Metatars	43 (33.8)	66 (37.9)
Other fractures	4 (3.1)	15 (8.6)

*) Significant difference ($p < 0.05$)

TABLE 3

Missed fractures in the control and intervention group.

Description	Case no.	Age, years	Gender
Missed fractures in the control group			
Undislocated fracture 4.5 cm proximally from the tip of the lateral malleolus[a]	1	71	Male
Salter Harris type 2 physis fracture in the lateral malleolus[a]	2	10	Male
Undislocated fracture 4.5 cm proximally from the tip of the lateral malleolus[a]	3	72	Female
Fracture of the distal part of the tibia and fibula[a]	4	31	Male
Missed fractures in the intervention group			
Undislocated fracture of the 5th metatarsal*	1	27	Male
A 6 mm avulsion of the lateral malleolus*	2	10	Female

a) Treated conservatively

examined. It also shows which fractures were diagnosed.

The OAR failed to identify two significant ankle fractures in the intervention group. Both were diagnosed within the first week and treated conservatively when the patients returned to the hospital as recommended by the OAR in cases of no clinical improvement. Hence, all significant fractures were diagnosed within an acceptable timeframe in the intervention group. Four significant fractures were missed in the control group. **Table 3** shows which fractures were missed in the control and intervention groups. No displaced fractures were missed in either group, and all missed fractures were treated conservatively.

The specificities of fracture detection in the two groups were 44% in the control group and 51% in the intervention group. This was statistically significant ($p < 0.05$). In the control group, 14% of patients had a fracture in the ankle or midfoot region, and in the intervention group, 17% had such fracture. There were no significant differences in the number of detected fractures between the two groups ($p = 0.1$).

We also registered how many came back for re-evaluation, but found no significant differences between the two groups ($p = 0.9$).

DISCUSSION

The main finding of the present study is that if the OAR had been introduced as outlined above, the number of radiographs would have been reduced by 7.6% or 89 per year in our clinical setting.

There were significantly more young patients in the intervention group than in the control group ($p < 0.05$). We do not believe that this introduced any significant bias. We did not register how many patients were seen by junior and more senior physicians in the two groups, but we cannot identify any circumstances which would have changed this ratio or altered the results.

It seems probable that more patients would come back for re-evaluation if fewer x-rays were taken, but that was not the case in the present study, as also confirmed in other clinical trials on the use of the OAR [9].

To our knowledge, very few other clinical decision rules have been shown to alter clinical practice. Other

studies have shown a high level of patient and physician satisfaction when using the AOR [9, 10]. The same studies have, not surprisingly, shown a reduction in the time spent in the ED and reduced medical costs.

We designed this study to investigate whether introduction of this very limited intervention without a constant reminder (e.g. a separate sheet of paper for each ankle/midfoot trauma) would significantly reduce the number of radiographs taken without increasing the number of missed significant fractures.

A systematic review reported a 30-40% reduction in the number of unnecessary radiographs when using the AOR [1]. The reduction reported in the present study was lower, which may have been so for a number of reasons. First, as opposed to most previous studies which have reminded or required the examining physician to use the OAR, the present study did not require physicians to fill in a separate form. This may have reduced the physicians' OAR compliance. Second, whereas other studies have included all the physicians of a ward, we only introduced the OAR to the new junior physicians who had less than a year's clinical experience. This group of physicians examines most of the patients in our ED. It is likely that a larger reduction in the number of x-ray examinations would have been achieved if all physicians examining patients in the ED had been introduced to the procedure. Third, most previous studies reported that about 80-85% of patients in the control group underwent x-ray examination; the corresponding proportion was only 62% in our clinical setting, wherefore it would be difficult to achieve a 30-40% decrease [1, 9].

Taking these factors into consideration, it is not surprising that the reduction of radiographs in our study was considerably lower than that of other studies. However, the present study shows that it is possible to achieve a significant reduction by using a very limited intervention, which is exactly what we were testing.

We have shown that a limited intervention produced a high sensitivity while reducing the number of radiographs taken. But, as shown in Table 1, we also registered that the percentage of patients who came back for re-evaluation was not higher in the control group than in the intervention group ($p = 0.9$). This shows that the intervention did not just postpone x-ray workload; as also demonstrated in previous studies [9].

When using the OAR in our ED, patients and physicians alike were reassured that the OAR enjoyed a sensitivity approaching 100% and that the number of radiographs could be reduced. The reduction in time spent in the ED may also save costs [9].

We conclude that when introduced in an ED in Denmark, the OAR will significantly reduce the number of radiographs performed, thereby reducing exposure to x-rays.

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CONFLICTS OF INTEREST: None

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