

A Prospective Study of Modified Ottawa Ankle Rules in a Military Population

Interobserver Agreement Between Physical Therapists and Orthopaedic Surgeons

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ABSTRACT

To determine the necessity of ankle and foot radiographs, we used modified Ottawa Ankle Rules to evaluate all cadets seen with an acute ankle or midfoot injury at the United States Military Academy. This scoring system determines the need for radiographs. Each patient was independently examined and the decision rules were applied by a physical therapist and an orthopaedic surgeon. Ankle and foot radiographs were obtained for all subjects. Sensitivity, specificity, and the positive predictive value were calculated in 153 patients. There were six clinically significant ankle fractures and three midfoot fractures, for a total incidence of 5.8%. For physical therapists, the sensitivity was 100%, the specificity for ankle injuries was 40%, and the specificity for foot injuries was 79%. For orthopaedic surgeons, the sensitivity was also 100%, the specificity for ankle injuries was 46%, and the specificity for foot injuries was 79%. Interobserver agreement between the orthopaedic surgeons and physical therapists regarding the overall decision to obtain radiographs was high, with a kappa coefficient value of 0.82 for ankle injuries and 0.88 for foot injuries. There were no false-negative results. Use of the modified Ottawa Ankle Rules would have reduced the necessity for ankle and foot radiographs by 46% and 79%, respectively.

Stiell et al.⁹ developed clinical-decision rules called the Ottawa Ankle Rules for health care providers to use in the emergency department setting. These rules were designed to minimize unnecessary radiographs for patients with acute ankle and foot injuries. The Ottawa Ankle Rules are considered positive and radiographs are indicated if there is bone tenderness at the posterior edge or tip of the lateral or medial malleolus (ankle series), the navicular or base of the fifth metatarsal (foot series), or there is inability to bear weight both immediately after injury and during examination.⁹ When clinicians apply these rules properly, they can accurately decide whether to order a radiograph for a patient with an acutely injured ankle or foot.

The Ottawa Ankle Rules were designed to decrease the number of false-negative radiographs. These clinical-decision rules have been found to significantly reduce costs and waiting time in an emergency department environment.^{1,7,11} Several prospective studies of the Ottawa Ankle Rules have been conducted in university and community hospital emergency departments and in a university-based community sports center.^{4-7,11,12} Results from several of the studies demonstrate that the Ottawa Ankle Rules significantly reduced the need to order radiographs without resulting in missed clinically significant fractures.^{7,11,12}

Loddy et al.⁵ introduced a modification to these rules: the "Buffalo" rule. The Buffalo modification changed the area of malleolar tenderness from the posterior borders of the malleoli to over the crests or midportion of the malleoli, away from the ligament attachments. Their intent for modifying the Ottawa Ankle Rules was to identify fracture tenderness while minimizing the effect of ligament tenderness at the posterior edges of the malleoli. Results from their study suggest that the modified Ottawa Ankle Rules, used in a university-based community sports medicine center, could significantly decrease the use of radiography

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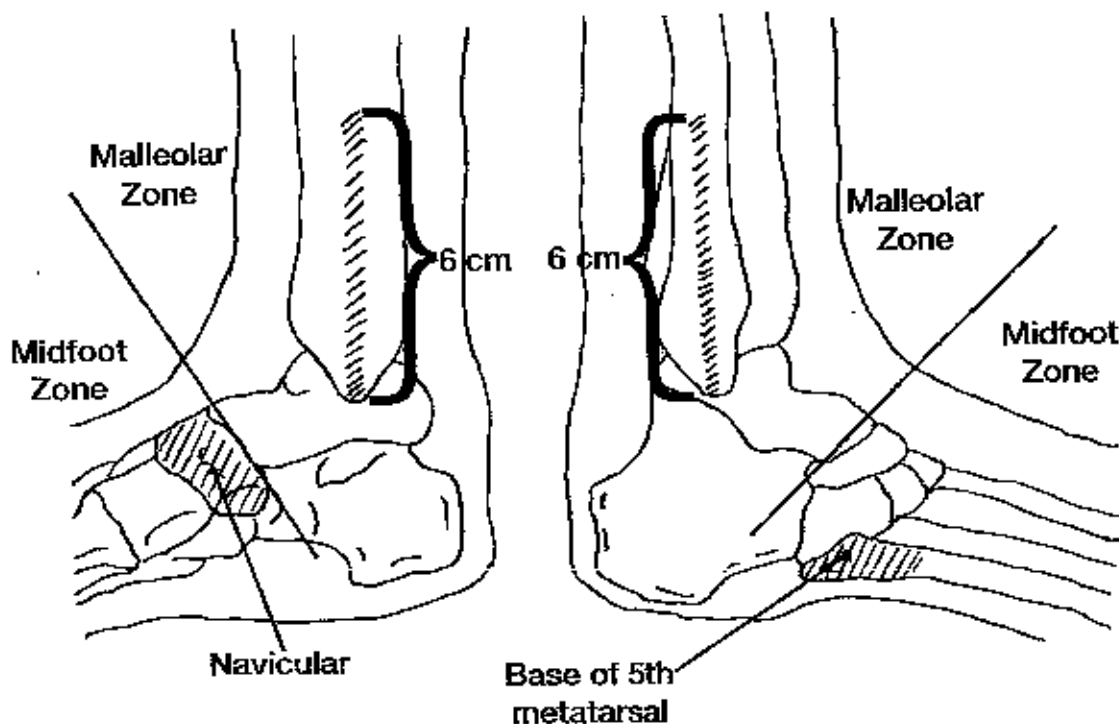


Figure 1. The modified Ottawa Ankle Rules are positive, and radiographs are indicated, if there is tenderness over the crests or midportions of the malleoli (ankle series) or the navicular or base of the fifth metatarsal (foot series) or if there is inability to bear weight both immediately after injury and during examination.

in patients with acute ankle and midfoot injuries without resulting in missed clinically significant fractures. They found the sensitivity for the new Buffalo rule was the same as for the original Ottawa Ankle Rules (100%), and the specificity for malleolar fracture was significantly greater than that of the original malleolar rule (59% versus 42%). The potential reduction in the need for radiographs was significantly greater at 54%.

Because cadets at the United States Military Academy are extremely active in athletics and military training, 350 to 400 acute ankle sprains are evaluated by trainers, therapists, and orthopaedic surgeons on an annual basis.^{3,5} Jackson et al.³ found that 33% of cadets sustained an ankle sprain during their 4-year training at the Military Academy (there are approximately 4000 cadets at the Academy each year). On the basis of these previously mentioned articles and the incidence of acute ankle and foot injuries at our institution, the necessity of obtaining radiographs for all these injuries has come into question.

The purpose of this study was to determine the potential reduction of the need for radiographs using the modified Ottawa Ankle Rules at our institution, where we see numerous acute ankle and foot injuries. We also evaluated the interobserver agreement between physical therapists and orthopaedic surgeons regarding the necessity to obtain radiographs.

MATERIALS AND METHODS

This study includes all patients who were examined for an acute foot or ankle injury at our orthopaedic walk-in clinic, "sick call," between October 1998 and May 1999. To be included in this study, patients had to be Military Academy cadets who had sustained an acute ankle or midfoot injury within the previous 10 days. The exclusion criteria, based on the studies of Stiell et al.,^{9,11,12} included injury more than 10 days old, isolated skin injury, pregnancy, altered sensorium, obvious ankle or foot deformity, second evaluation for the same injury, and prior ipsilateral ankle or foot injuries. All patients who met the inclusion criteria in this study agreed to participate and informed consent was obtained. The study protocol was approved for human use by the Human Subjects Research Review Board (HSRRB), West Point, New York.

Two physical therapists, both credentialed as neuromusculoskeletal physician extenders, served as evaluators during this study. The primary investigator (BAS), an Army physical therapist, evaluated 149 ankles, and an Air Force physical therapist evaluated 8. Five orthopaedic surgeons served as the orthopaedic evaluators. All were board-certified with subspecialty training in orthopaedic sports medicine. For all subjects, age, sex, side of injury, and days since injury were collected after informed consent was obtained. Each patient was independently exam-

TABLE 1
Location and Number of Fractures

Fracture	Number
Navicular	3
Talus	2
Lateral malleolus	2
Anterior process calcaneus	1
Posterior tibia	1

ined by a physical therapist and then by one of the orthopaedic surgeons, who were blinded to the results recorded by the physical therapist.

The modified Ottawa Ankle Rules were positive and radiographs of the foot or ankle were necessary if the following conditions existed: 1) Tenderness was present over the midportion or crest of the bone from the tip of each malleolus to 6 cm proximal to the tip (Buffalo Ottawa Ankle Rules modification),⁵ or over the navicular or base of the fifth metatarsal (Fig. 1)⁹ or 2) The patient could not bear weight both immediately after the injury and in the clinic.⁹ Weightbearing is described as the ability to transfer weight twice onto each leg (a total of four steps), regardless of limping or discomfort.⁵ Patients were encouraged to walk but were never forced. The modified Ottawa Ankle Rules were considered negative if there was no tenderness over the bone and the subject could bear weight either immediately after the injury or in the clinic.

Ankle and foot radiographs were then obtained on all patients. Ankle radiographs included AP, lateral, and mortise views. Foot radiographs included dorsiplantar, lateral, and oblique views. The orthopaedic surgeon who examined the patient and applied the modified Ottawa Ankle Rules then interpreted the radiographs and recorded the results before initiating a treatment plan. Patients were treated in a

standardized fashion depending on the diagnosis. A fracture was considered clinically significant if there was a bone fragment more than 3 mm in breadth or if any other non-avulsion fracture requiring cast immobilization was found.^{6,9} All radiographs were read by one of two radiologists at a later time. The radiologists were blinded to the modified Ottawa Ankle Rules predictions.

Using two-by-two contingency tables, we determined the specificity, sensitivity, positive predictive values, and negative predictive values for the results with 95% confidence intervals. Interrater agreement between the physical therapists and orthopaedic surgeons was evaluated by calculation of a kappa coefficient.

RESULTS

From October 1998 to May 1999, 156 patients gave informed consent to participate in the study. Three were excluded when the initial evaluation revealed one with Achilles tendinitis, one with a stress reaction of a metatarsal, and one with no significant ankle or foot injury. Therefore, 153 patients were enrolled in the study. Four patients sustained bilateral ankle injuries during the study collection period, making the total number of injuries 157. Correspondingly, 157 ankle radiographs were obtained. Three patients did not have complete foot radiographs, leaving 154 foot radiographs for evaluation. All patients were evaluated initially by a physical therapist and then by an orthopaedic surgeon.

The average age of the patients was 20.25 years (range, 18 to 25). There were 123 men and 30 women. The left lower extremity was injured in 72 patients, the right in 85 patients. The mechanism of injury was trauma during sports activity, running, or military training. Patients

TABLE 2
Outcome of the Modified Ottawa Ankle Rules for Identifying the Need for Ankle and Foot Radiographs When Used by Physical Therapists

	Ankle		Foot	
	Fracture	No fracture	Fracture	No fracture
Modified Ottawa Ankle Rules				
Positive	6	90	3	32
Negative	0	61	0	119
Sensitivity	1.0 (0.93-1.0)		1.0 (0.93-1.0)	
Specificity	0.40 (0.32-0.48)		0.79 (0.73-0.85)	
Positive predictive value	0.062 (0.024-0.10)		0.086 (0.042-0.13)	
Negative predictive value	1.0 (0.93-1.0)		1.0 (0.93-1.0)	

TABLE 3
Outcome of the Modified Ottawa Ankle Rules for Identifying the Need for Ankle and Foot Radiographs When Used by Orthopaedic Surgeons

	Ankle		Foot	
	Fracture	No fracture	Fracture	No fracture
Modified Ottawa Ankle Rules				
Positive	6	81	3	32
Negative	0	70	0	119
Sensitivity	1.0 (0.93-1.0)		1.0 (0.93-1.0)	
Specificity	0.46 (0.38-0.54)		0.79 (0.73-0.85)	
Positive predictive value	0.069 (0.029-0.109)		0.086 (0.042-0.130)	
Negative predictive value	1.0 (0.93-1.0)		1.0 (0.93-1.0)	

were evaluated on average 2.17 days (range, 1 to 10) after injury.

There were six clinically significant ankle fractures, for an incidence of 3.8%, and three clinically significant midfoot fractures, for an incidence of 1.95%. This provided a total incidence of 5.8% of patients who had at least one fracture (Table 1). No subjects had fractures of both the ankle and midfoot. Eight of the nine subjects with clinically significant fractures were male.

When physical therapists used the modified Ottawa Ankle Rules to predict the necessity for ankle radiographs, sensitivity was 100%, specificity was 40%, and the positive predictive value was 0.062. The negative predictive value was 1.0. Applying these rules to predict the necessity for foot radiographs, we found the sensitivity remained at 100%, specificity was 79%, and the positive predictive value was 0.086, with a negative predictive value of 1.0 (Table 2).

When orthopaedic surgeons applied the modified Ottawa Ankle Rules, the sensitivity for ankle injuries was 100%, specificity was 46%, the positive predictive value was 0.069, and the negative predictive value was 1.0. When these same rules were applied for the necessity of foot radiographs, the sensitivity remained 100%, specificity was 79%, the positive predictive value was 0.086, and the negative predictive value was 1.0 (Table 3).

The modified Ottawa Ankle Rules decreased the need for ankle radiographs by 40% when applied by the physical therapists and by 46% when used by the orthopaedic surgeons. The need for foot radiographs was decreased by 79% in both groups. Interobserver agreement between physical therapists and orthopaedic surgeons regarding the overall decision to obtain radiographs was high, with a kappa coefficient value of 0.82 (95% confidence interval, 0.75 to 0.87) for the ankle and 0.88 (95% confidence interval, 0.83 to 0.93) for the foot. Physical therapists and orthopaedic surgeons agreed in 82% of the cases regarding the overall decision to order ankle radiographs and in 88% of the cases regarding the necessity for foot radiographs.

Interobserver agreements of each of the six components of the decision rules was high. The kappa value for medial malleolar tenderness was 0.82, for lateral malleolar tenderness it was 0.80, and for inability to bear weight both immediately after injury and in the clinic it was 0.95 for the ankle and 0.97 for the foot. The kappa value for navicular tenderness was 0.91 and for tenderness at the base of the fifth metatarsal was 0.94. The best agreement was found with the inability to bear weight criterion, and the worst agreement was with lateral malleolar tenderness. The best interobserver agreement using palpation was at the base of the fifth metatarsal.

DISCUSSION

Ankle and midfoot injuries are seen frequently in a number of clinical settings. Emergency treatment areas, outpatient clinics, training rooms, and sports medicine clinics evaluate such injuries on a daily basis. In an effort to reduce the number of unnecessary radiographs, and thereby reduce radiation exposure, cost, and patient wait-

ing times, Stiell et al.,⁹ at the University of Ottawa and the Ontario Ministry of Health, developed the Ottawa Ankle Rules. The authors designed these rules to be 100% sensitive and thereby avoid false-negative results and missed diagnoses. The authors applied these rules to patients with significant ankle and midfoot injuries and reduced the number of radiographs by one-third.^{9,10} In contrast, two other institutions failed to achieve 100% sensitivity when these rules were applied.^{4,6} Kelly et al.⁴ reported a sensitivity of 93% and a false-negative rate of 14% based on 75 fractures in 350 patients. They concluded that five fractures would have been missed with the application of these clinical-decision rules. In a study by Lucchesi et al.,⁶ the sensitivity was 94.6% for ankle fractures and 93.1% for midfoot fractures. The Ottawa Ankle Rules failed to predict 5 of the 93 ankle fractures and 2 of the 29 midfoot fractures.

Although the Ottawa Ankle Rules were originally intended for use in an emergency department or trauma center setting, Leddy et al.⁵ reported the application of these rules in a university-based community sports medicine center. They introduced a modification to the original rules and coined the term, the Buffalo rule. This rule emphasizes palpation over the midcrest of the malleoli and away from ligament attachments so as to improve specificity for fracture diagnosis. Using this modification, Leddy et al. reported 100% sensitivity, with a specificity of 59% for malleolar fracture.

Cadets at the United States Military Academy participate in club, intramural, and varsity athletics, as well as in demanding military training. On a consistent basis, 350 to 400 ankle sprains are evaluated annually at the Academy. We decided to implement the modified Ottawa Ankle Rules as proposed by Leddy et al. to investigate the necessity for obtaining radiographs in patients with acute ankle and midfoot injuries. We rationalized that at the Academy ankle and foot injuries occur for the most part during low-velocity sporting and military training. Thus, our clinical environment is similar to that described by Leddy et al. When these rules were applied at our institution, we documented 100% sensitivity for ankle and midfoot fractures, which is consistent with several previously mentioned studies. Compared with these other studies, we found the rules to have moderate specificity for ankle fractures (40% to 46%) and high specificity for midfoot fractures (79%). Although we had a small number of clinically significant fractures (9 fractures in 157 injuries, for an incidence of 5.8%), this is consistent with the incidence reported by several other authors when evaluating such injuries occurring during sports participation. Garrick,² in his retrospective study, reported an incidence of only 2.4% ankle fractures (4 of 164 ankle injuries) in a similar sports medicine center practice. Leddy et al.⁵ found an 8.3% incidence of fractures (11 of 132 patients) in their outpatient university-based community sports medicine center. The relatively low number of fractures in these studies reflect the low-energy mechanisms of injury that occur with athletic trauma, as opposed to high-energy trauma associated with motor vehicle accidents, for example.

Unique to our study was the attempt to compare the overall agreement of the modified Ottawa Ankle Rules between orthopaedic surgeons and physical therapists. There is one previous study comparing the agreement of these rules between physicians and nonphysicians.⁷ In that study, by Pigman et al.,⁷ the authors used triage nurses and emergency department physicians to apply the rules and found no significant difference between these examiners and the overall accuracy of the decision rules. They reported a moderate 61% interobserver agreement between physicians and triage registered nurses. They demonstrated perfect agreement on all components of the clinical decision rules in only 47% of the cases. In our study, we compared physical therapists and orthopaedic surgeons and found a significant overall agreement to order radiographs in 82% of ankle injuries and 88% of foot injuries. Kappa coefficients for each of the components of the Ottawa Ankle Rules remained high and ranged from 0.80 for lateral malleolar tenderness to 0.97 for the inability to bear weight.

We must strongly emphasize that military physical therapists are typically used as physician extenders, credentialed as neuromusculoskeletal screeners, and frequently receive additional training in clinical diagnoses of musculoskeletal injuries. They perform initial evaluations for a myriad of orthopaedic and sports injuries, often without physicians' direct referral. This study provides further evidence that physical therapists, when appropriately trained, can function well as physician extenders and can obtain interobserver agreement with orthopaedic surgeons when applying the modified Ottawa Ankle Rules as used in this setting.

Physical therapists and orthopaedic surgeons can use the modified Ottawa Ankle Rules in a sports medicine clinic setting. In our study, no clinically significant fractures were missed, and the decision rules theoretically reduced the need to order ankle radiographs by 40% for physical therapists and by 46% for orthopaedic surgeons. Furthermore, the necessity for obtaining foot radiographs

would have been reduced by 79%. We were able to demonstrate that physical therapists with additional training in orthopaedic sports physical therapy and orthopaedic surgeons can have high overall interobserver agreement about when to order ankle and foot radiographs based on the modified Ottawa ankle rules.

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