American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Suspected Ankle Fractures**

Variant 1: **Patient Meeting Ottawa Rules.**

1. **Inability to bear weight immediately after the injury OR**
2. **Point tenderness over the medial malleolus, or the posterior edge or inferior tip of the lateral malleolus or talus or calcaneus OR**
3. **Inability to ambulate for four steps in the emergency department.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle	9	AP, lateral, and mortise views.	☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

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Summary of Literature Review

The musculoskeletal expert panel has reviewed pertinent articles dealing with adult patients with ankle injuries. The reviewed papers were primarily concerned with missed fractures and improving fracture detection [1-5] or with the establishment of clinical criteria that would decrease the number of ankle radiographs without missing significant injuries [6-17].

Radiography

In one large series, radiographs were obtained in 89% of all patients who presented to the emergency department with a history of extremity trauma; 17% of these cases had abnormalities that altered treatment [7]. Ankle radiographs accounted for approximately 10% of all radiographs ordered in the emergency department [9]; they are the third most common study ordered and are exceeded in frequency only by chest and cervical spine radiographs [9]. Stiell and colleagues reported that more than 92% of patients with ankle trauma in the ER setting had radiographs ordered [18]. In a retrospective review of more than 600 patients, Vargish et al [17] found that fewer than 25% had adequate physical examinations, and more than 99% had radiographs. In another study, all patients for whom radiographs were ordered were subjected to a physical examination by the radiology resident; there were no significant differences in the percentages of indicated studies ordered by triage personnel and residents in the emergency department [2]. The percentage of significant injuries detected on the radiographs was equivalent for the two groups [2]. It is, therefore, not surprising that radiographs taken by nurse practitioners, nurses, and medical students had similar percentages of abnormal findings because radiographs were ordered for almost everyone seen with ankle trauma.

Gleadhill et al [10] concluded that it is possible to establish guidelines that would increase the quality and efficiency of service and influence the diagnostic skills and referral habits of physicians ordering ankle radiographs in the emergency department. In a prospective study of 500 patients with inversion injuries of the ankle, Dunlop et al [9] concluded that radiographs should be performed only for patients with distal fibula tenderness or inability to bear weight, or who are older than age 60. In these older patients, material swelling was absent in 11% of malleolar fractures and in two of four calcaneal fractures [17]. Sujitkumar et al [19] analyzed 2,000 ankle injuries and concluded that swelling alone is an unreliable indicator of injury and that patients with minimal pain and swelling who are able to bear weight do not require radiographs. Stiell et al [14-16,18,20], in a number of well-designed, elaborate papers, concluded that focal tenderness over the malleolus and the inability to bear weight will detect virtually 100% of patients with significant ankle fractures. They evaluated 1,032 patients prospectively and validated their criteria on 453 new patients [14]. They believed that if this rule is used, significant fractures could be detected with a sensitivity of 1 (100%) and a confidence level of 95% [14]. Foot and ankle radiographs could be reduced 30% without missing any significant injuries [14]. When these rules were implemented there was a decrease in the number of ankle radiographs ordered, which decreased patient waiting times and costs without patient dissatisfaction or missed fractures [20]. This study was confirmed at an independent site by Pigman et al who reported a 19% reduction in ankle and midfoot radiographs [21].

In the clinical setting, radiographs of the foot and ankle are often obtained together, even though the pain can almost always be localized to one area or another. Ordering may reflect an inadequate clinical examination; on the rare occasions when fifth-metatarsal fractures occur in association with inversion injuries of the ankle, they can be detected clinically. In the presence of an inversion injury of the ankle, foot radiographs have no role in management [22]. It is widely accepted that an adequate radiograph of the ankle should include the base of the fifth metatarsal bone distal to the tuberosity.

An evaluation of the traumatized ankle should consist of anteroposterior (AP), lateral, and mortise views of the ankle [3]. Additional views can be added to the minimal series in questionable cases. The fifth metatarsal base distal to the tuberosity should be seen on at least one projection. The use of a pertinent clinical history for the site of point tenderness will decrease the miss rate for subtle fractures by approximately 50% [12].

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Ottawa Ankle Rules

The committee believed that the guidelines established by Stiell et al [14-16] and confirmed by Pijnenburg et al [13] should be adopted in the evaluation of patients with ankle trauma. These guidelines suggest obtaining ankle radiographs in patients with the following clinical findings: 1) inability to bear weight immediately after the injury, or 2) point tenderness over the medial malleolus, or the posterior edge or inferior tip of the lateral malleolus or talus or calcaneus, or 3) inability to ambulate for four steps in the emergency department. It has been convincingly demonstrated that one can approach a sensitivity of 100% in excluding significant ankle fractures using these simple criteria [10,14-16]. Limiting ankle radiographs to patients who meet these criteria can eliminate a considerable number of ankle and midfoot radiographs (estimated range 19%-36%) without missing significant injuries [10]. This would result in a considerable savings in patient cost and waiting time.

The validation and cost effectiveness of these rules have been confirmed in multiple subsequent series [6,11,13,23].

Occult Ankle Fractures

Clark et al [4,5] have shown that occult fractures of the ankle may present with a large ankle effusion (>15 mm) in the absence of a visible fracture. However, this is an uncommon imaging scenario in that it occurred in less than 1% of all the radiographs taken in the study. The vast majority of ankle radiographs with a large joint effusion had a visible fracture on the radiograph. In those rare cases in which a large joint effusion is seen on the radiograph but no fracture is visible, a computed tomography (CT) scan will demonstrate a fracture in a third of these cases.

Computed Tomography

Haapamaki et al [24] used multidetector CT (MDCT) of the ankle in multitrauma patients and compared the MDCT findings with the radiographs. When compared to MDCT, radiographs were 87% sensitive in detecting calcaneal fractures, 78% sensitive in detecting talar fractures, and 25%-33% sensitive in detecting midfoot fractures. Only 5 of 21 Lisfranc fracture dislocations were detected on radiographs. They recommended MDCT for patients with high-energy polytrauma and in those with complex foot and ankle fractures.

Magnetic Resonance Imaging

Remplik et al [25] compared low-field (0.2 Tesla) magnetic resonance imaging (MRI) and conventional radiography and found no statistical difference in the detection of acute fractures of the distal extremities. Nikken et al [26] compared clinical outcomes (need for eventual treatment of an injury) between radiography and MRI in the setting of acute ankle trauma and found that a positive radiograph was a better positive predictor of the need for treatment than a positive MRI. However, neither a negative radiograph nor a negative MRI was good at predicting lack of need for future treatment of an injury.

In summary, the three-view ankle radiographic examination is good at identifying fractures that will need immobilization and/or surgical intervention for treatment. A negative radiographic or MRI examination is not sufficient to exclude those patients who may eventually need immobilization and/or surgical intervention; therefore, clinical follow-up is essential in the patient who has suffered an acute ankle injury but has negative imaging studies.

Summary

- In a patient who meets the Ottawa Rules for a suspected ankle fracture, a three-view (AP, lateral and mortise) ankle radiographic study is indicated.
- If the radiograph is negative, clinical follow-up is warranted for ruling out an ankle injury that may eventually need treatment.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢ ☢	0.1-1 mSv	0.03-0.3 mSv
☢ ☢ ☢	1-10 mSv	0.3-3 mSv
☢ ☢ ☢ ☢	10-30 mSv	3-10 mSv
☢ ☢ ☢ ☢ ☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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