American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute Trauma to the Ankle**

Variant 1: **Adult or child >5 years old. Patient meets Ottawa Ankle Rules:**

1. **Inability to bear weight immediately after the injury, OR**
2. **Point tenderness over the medial malleolus, the posterior edge or inferior tip of the lateral malleolus, talus, or calcaneus, OR**
3. **Inability to ambulate for 4 steps in the emergency department.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle	9	Obtain 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**

Variant 2: **Adult or child >5 years old. Acute injury to the ankle; does not meet the Ottawa Ankle Rules. No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Neurologically intact (including no peripheral neuropathy). First study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle	1	Obtain AP, lateral, and mortise views.	☢
CT ankle without IV contrast	1		☢
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without IV contrast	1		O
MRI ankle without and with IV contrast	1		O
US ankle	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 3: **Adult or child >5 years old. Acute injury to the ankle. Does not meet Ottawa Ankle Rules. Patient is not neurologically intact and/or has a peripheral neuropathy that involves the ankle and foot. First study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle	9		☢
CT ankle without IV contrast	1		☢
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without IV contrast	1		O
MRI ankle without and with IV contrast	1		O
US ankle	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Acute Trauma to the Ankle**

Variant 4: **Adult or child >5 years old. Acute injury to the ankle with persistent pain. Radiographs not obtained at time of injury. Initial study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle	9	Obtain AP, lateral, and mortise views.	☢
CT ankle without IV contrast	1		☢
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without IV contrast	1		O
MRI ankle without and with IV contrast	1		O
US ankle	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 5: **Adult or child >5 years old. Acute injury to the ankle with >1 week persistent pain. Initial radiographs negative.**

Radiologic Procedure	Rating	Comments	RRL*
MRI ankle without IV contrast	6		O
X-ray ankle	5	Obtain AP, lateral, and mortise views.	☢
CT ankle without IV contrast	5		☢
US ankle	5		O
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without and with IV contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 6: **Adult or child >5 years old. Acute injury to the ankle. Radiographs demonstrate talus fracture. Next study.**

Radiologic Procedure	Rating	Comments	RRL*
CT ankle without IV contrast	9		☢
X-ray ankle Broden's view	5		☢
MRI ankle without IV contrast	5		O
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without and with IV contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Acute Trauma to the Ankle**

Variant 7: **Adult or child >5 years old. Acute injury to the ankle. Radiographs suggest an osteochondral injury. Next study.**

Radiologic Procedure	Rating	Comments	RRL*
MRI ankle without IV contrast	8		O
CT ankle without IV contrast	5		☢
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without and with IV contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 8: **Adult or child >5 years old. Acute injury to the ankle. Radiographs and/or physical examination suggest syndesmotic injury. Next study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray tibia/fibula	9	Obtain AP and lateral views.	☢
MRI ankle without IV contrast	8		O
CT ankle without IV contrast	5		☢
CT ankle with IV contrast	1		☢
CT ankle without and with IV contrast	1		☢
MRI ankle without and with IV contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

ACUTE TRAUMA TO THE ANKLE

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Summary of Literature Review

Introduction/Background

The musculoskeletal expert panel reviewed pertinent articles dealing with patients with ankle injuries. The reviewed papers were primarily concerned with missed fractures and improving fracture detection [1-4] or with the establishment of clinical criteria that would decrease the number of ankle radiographs without missing significant injuries [5-15].

Ankle injuries are frequently diagnosed and treated in United States emergency departments (ED) with an incidence of approximately 200 visits per 100,000 person-years [16,17]. Of patients with acute ankle injuries undergoing radiographic evaluation the incidence of ankle fracture varies widely with season [18], athletic activity [19], and practice setting, ranging from 2.4% in outpatient sports medicine centers [20] to greater than 20% in the ED setting [21]. Recent evidence-based clinical treatment guidelines [22-24] and systematic review of economic analyses [25] support the role of radiography in evaluation of select patients suspected of having an ankle fracture with a limited role of cross-sectional imaging primarily as a tool for preoperative planning and as a problem-solving technique in patients with persistent symptoms and suspected of occult fracture.

Variant 1: Patients Meeting Ottawa Rules – Inclusion Criteria.

Given the relatively low incidence of fracture in patients experiencing ankle trauma, the Ottawa Ankle Rule (OAR) criteria [13] were established to identify those patients with sufficiently low probability of fracture that they can safely be treated without radiographic evaluation. Subsequently, the validation and cost-effectiveness of these guidelines have been confirmed in numerous studies and have been extended to a variety of outpatient practice settings [5,10,12,26-28]. These guidelines recommend ankle radiographs in patients with the following clinical findings: 1) inability to bear weight immediately after the injury and take 4 steps in the ED or 2) bone tenderness at the posterior edge and tip of either malleolus. Application of the OAR for evaluation of acute trauma to the foot is reported in a separate ACR Appropriateness Criteria®.

In a 2003 systematic review of 27 studies including 15,581 patients, the sensitivity of the OAR in excluding fracture was 97.6 (95% confidence interval [CI], 96.4–98.9), median specificity was 31.5 (95% CI, 23.8–44.4), and the pooled OAR had a negative likelihood ratio of 0.10 (95% CI, 0.06–0.16) [29]. Using these guidelines, <2% of those who are negative for fracture using the OAR actually have a fracture. Although originally derived for adult patients, a systematic review of studies including patients ≤18 years of age found the OAR had a pooled sensitivity of 99% (95% CI, 97%–99%) and specificity range of 8%–50% [30]. In an attempt to improve specificity, the OAR guidelines have been modified by changing the area of palpation from the posterior edge to the midportion of the malleoli (Buffalo modification) [31] using a tuning force to test for pain in the malleolus (tuning fork test) [32] or by applying indirect force on the bone (Bernese Ankle Rules) [33]. These modifications have not been widely adopted or tested in independent trials.

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. In a retrospective review of 243 patients presenting with isolated acute ankle symptoms who simultaneously had ankle and foot radiographs, 55 had fractures including 9

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fractures at the base of the fifth metatarsal, which were visualized on the ankle series. No additional fractures were identified on the dedicated foot radiographs [34]. In the presence of an inversion injury of the ankle, foot radiographs have no role in management [35]. 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. In the setting of suspected deltoid ligament disruption following supination-external rotation injuries of the ankle, a gravity-stress view has been shown to be as reliable and is perceived to be more comfortable than that obtained with manual stress [36]. 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% [11].

Variants 2 and 3: Acute Ankle Trauma in Patients Not Meeting Ottawa Rules Inclusion Criteria.

The OAR are validated in children >5 years of age [30] and should not be used in patients with decreased sensation [37,38] or inability to communicate.

Variants 4 and 5: Acute Injury to the Ankle With Persistent Pain. Initial Radiograph Negative or Not Obtained at Time of Injury.

Persistent pain following trauma may be associated with a radiographically occult fracture or soft-tissue injury. Clark et al [4,39] 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 <1% of all the radiographs taken in the study. The vast majority of ankle radiographs with a large joint effusion following trauma 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. The spiral fracture of the distal tibia is frequently associated with a nondisplaced fracture of the posterior malleolus of the tibia that may not be demonstrated on radiographs [40].

Haapamaki et al [41] used multidetector CT (MDCT) of the ankle in multitrauma patients and compared MDCT findings with 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. Remplik et al [42] compared low-field (0.2T) 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 [43] 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. A systematic review of MRI bone marrow edema lesions associated with acute ankle injury found the clinical prognosis of patients with these lesions is good and requires no specific treatment [44].

In skeletally immature patients with an open distal fibular physis and focal tenderness of the lateral malleolus the incidence of occult Salter Harris I fracture on initial radiographs was reported to be 18% with no displacement of the fracture on follow-up radiographs [45]. An analysis of 30 pediatric patients undergoing MRI for evaluation of acute ankle fracture found MRI provided no additional therapeutic value [46].

Variant 6: Acute Injury to the Ankle. Radiographs Demonstrate Talus Fracture. Next Study.

Although an uncommon injury, a series of studies report fractures of the talus that are not demonstrated on standard radiographic views [47-52]. Lateral process fractures of the talus are increasing in frequency with the growing popularity of snowboarding [53]. These patients typically present with a history of rapid inversion and dorsiflexion with point tenderness anterior and inferior to the lateral malleolus [54]. These fractures may be minimally displaced and misdiagnosed as lateral ankle sprains [55,56]. Evaluation of fragment displacement can be improved with the use of Broden view or, more frequently, with MDCT.

MDCT is recommended for preoperative planning for patients with high-energy polytrauma and in those with complex foot and ankle fractures [57]. Although there are limited data regarding diagnostic accuracy, clinical treatment reviews recommend CT to determine degree of displacement in the preoperative planning evaluation for fractures of the talus [58,59].

Variant 7: Acute Injury to the Ankle. Radiographs and/or Physical Examination Suggest an Osteochondral Injury. Next Study.

Approximately 50% of ankle sprain injuries [57] and 70% of ankle fractures [60] are likely to result in some form of cartilage injury. Although radiographs can demonstrate displaced osseous lesions and associated fractures, they do not demonstrate cartilage or bone contusions related to osteochondral lesions. In cases with persistent pain and symptoms of locking, clicking, stiffness, and ankle swelling, MRI is the study of choice to identify, quantify, and differentiate chondral lesions [61]. In a study evaluating patients without radiological abnormalities with MRI within 48 hours of the traumatic episode an osteochondral lesion was identified in 3 of 38 (8%) cases [62]. In a recent comparison 3T MRI has been shown to have greater diagnostic accuracy than 1.5T for evaluation of the articular surface and integrity of the subchondral bone plate [63].

Variant 8: Acute Injury to the Ankle. Radiographs and/or Physical Examination Suggest Syndesmotic Injury. Next Study.

Due to clinical limitations in diagnosing injuries of the syndesmosis, MRI has been recommended as an adjunct in select cases [64]. In a prospective study of 51 subjects, Hermans et al [65] found the Lauge-Hansen classification of fracture predicted syndesmotic injury identified with MRI with a sensitivity of 0.92 (95% CI, 0.79–0.98) and a specificity of 0.92 (95% CI, 0.64–0.998). Patients with a proximal fibular fracture and syndesmotic injury (Maisonneuve fracture) may not have localized rest pain at the site of fracture, and the severity of the injury may be overlooked during physical exam if the proximal fibula is not carefully palpated [66]. Radiographic evaluation of the tibia and fibula are recommended if there is any focal tenderness of the proximal fibula.

In summary, the 3-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 OAR for a suspected ankle fracture, a 3-view (AP, lateral, and mortise) ankle radiographic study is indicated.
- If the radiograph is negative, clinical follow-up is warranted to rule 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 "Varies".		

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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