American College of Radiology
ACR Appropriateness Criteria®
Acute Trauma to the Ankle

Variant: 1 **Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography ankle	Usually Appropriate	☢
US ankle	Usually Not Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
MRI ankle without IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
CT ankle without IV contrast	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢

Variant: 2 **Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US ankle	Usually Not Appropriate	O
Radiography ankle	Usually Not Appropriate	☢
MRI ankle without and with IV contrast	Usually Not Appropriate	O
MRI ankle without IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
CT ankle without IV contrast	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢

Variant: 3 **Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography ankle	Usually Appropriate	☢
CT ankle without IV contrast	May Be Appropriate	☢
US ankle	Usually Not Appropriate	O
Radiography ankle stress views	Usually Not Appropriate	☢

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without and with IV contrast	Usually Not Appropriate	O
MRI ankle without IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢

Variant: 4 Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
CT ankle without IV contrast	Usually Appropriate	☢
Radiography ankle	May Be Appropriate	☢
Radiography ankle stress views	May Be Appropriate	☢
US ankle	Usually Not Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢

Variant: 5 Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
CT ankle without IV contrast	Usually Appropriate	☢
Radiography ankle Broden's view	May Be Appropriate	☢
US ankle	Usually Not Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢

Variant: 6 Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography ankle stress views	Usually Appropriate	☢
Radiography leg	Usually Appropriate	☢
MRI ankle without IV contrast	Usually Appropriate	O
CT ankle without IV contrast	Usually Appropriate	☢
US ankle	Usually Not Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢

| Bone scan ankle | Usually Not Appropriate | ☢☢☢ |

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Summary of Literature Review

Introduction/Background

Ankle injuries are the most common injury presenting to primary care and emergency rooms [1,2], accounting for 4.4% of United States emergency room visits [3]. Acute ankle sprains (pain, swelling, limited mobility) make up the majority of these injuries, with an estimated incidence of 2 million per year [4]. Diagnosis of presence and degree of sprain, fracture, subluxation, dislocation, cartilage abnormalities, foreign bodies, or neurovascular involvement are critical in determining appropriate and timely orthopedic fixation/treatment planning [1,5] and to avoid chronic pain and immobility. Appropriate use of ankle imaging guidelines and clinical decision support mechanisms is paramount [6,7].

The current standard clinical imaging guidelines to determine if radiographs are necessary are the Ottawa Ankle Rules (OAR), instituted in 1992. The OAR have been validated for adults and children >5 years of age [8] and recommend ankle radiographs in patients with the following clinical criteria in the acute setting: 1) inability to bear weight, 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. For the purposes of this paper, the OAR will still apply during the first 1- to 3-week interval following initial injury. Multiple validation studies have confirmed OAR effectiveness and utility in obtaining appropriate imaging, reducing unnecessary radiographs and costs, and improving clinical outcomes [8-13].

Two recent meta-analyses concluded that the OAR are the most accurate in excluding fractures in the acute ankle setting with sensitivity of 92% to 100% with specificity of 16% to 51%, respectively [13,14]. Including an added criterion of swelling has been shown to increase the sensitivity and specificity for fracture to 100% and 55% for the malleolar region. Recent implementation of nurse triage programs using the radiographic OAR protocol have shown a reduction in emergency room patient stay by up to 20 minutes [3,15-17]. In an effort to decrease the use of radiographs, other rules, including the Bernese Ankle Rules, have been evaluated but have shown lower sensitivity to the OAR [18,19]. Evidence-based clinical treatment guidelines and systematic review of economic analyses 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 [5,6,20-23].

Application of the OAR for evaluation of acute trauma to the foot is reported in the ACR Appropriateness Criteria® topic on "Acute Trauma to the Foot" [24].

Exclusionary Criteria

OAR should not be used in children <5 years of age or in those patients with a neurologic abnormality affecting the lower leg with decreased sensation (eg, diabetic), altered sensorium, or inability to communicate [8,25,26]. Other possible cautionary or exclusionary scenarios include pregnancy, penetrating trauma, or presence of prior recent outside radiographs on transfer.

Special Imaging Considerations

Avoidance of manipulation of the ankle prior to radiographs in the absence of neurovascular deficit or critical skin injury is recommended in order to avoid remanipulation or complication in this setting [27]. Advances in MRI technology have facilitated short dedicated extremity MRI protocols in some centers that may be used as an emergent adjunct to radiographs [28].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.
A. Bone scan ankle

Bone scan is not routinely used as the first imaging study for the evaluation of acute trauma to the ankle with positive OAR.

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma

to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.

B. CT Ankle

Although CT may be used in polytrauma patients to determine the extent of injury in complex fractures, CT is not routinely used as the first imaging study of acute trauma to the ankle with positive OAR when exclusionary criteria do not apply.

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.

C. MRI Ankle

Although MRI may be used for occult injuries or suspicion for ligamentous tears in inversion injuries [29], it is not the first imaging study for the evaluation of acute trauma to the ankle with positive OAR.

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.

D. Radiography Ankle

Radiographs are indicated in patients who meet OAR criteria as the initial imaging study. Studies demonstrate between 92% and 99% sensitivity for detecting ankle fracture using these guidelines, with <2% of those who are negative for fracture using the OAR actually having a fracture [13-15,30]. The OAR are validated in children >5 years of age and should not be used in patients meeting the exclusionary criteria listed above [8]. Typical radiographic protocols should include 3 standard views: anteroposterior, lateral, and mortise views to include the base of the fifth metatarsal bone distal to the tuberosity [31]. Although foot and ankle radiographs have been performed together in clinical settings in the past, in a retrospective study of 243 patients with both radiographs performed, no foot fractures other than the base of the fifth metatarsal were noted. In the presence of inversion injury or fracture of the ankle, foot or knee radiographs should not be performed owing to low yield [32,33].

Weight-bearing radiographs, if possible, provide important information, particularly with fractures of uncertain stability, because the most important criterion in treatment of malleolar fractures is stability. A medial clear space of <4 mm should confirm stability. Increased incidence of fracture and instability is noted with medial tenderness, bruising or swelling, fibular fracture above the syndesmosis, bi- or trimalleolar fractures, open fracture, or high-energy fracture injury [34]. Special scenarios that warrant special mention and additional views include:

· *Axial Harris-Beath view:* The axial Harris-Beath view is used for suspected calcaneal fractures and to determine intra-articular extent.

· *Broden view:* The Broden view is a supine flexed knee view with 30° to 45° internal rotation that can be used for specific improved evaluation of the lateral process fracture of the talus (commonly known as snowboarder's fracture). It may be of use when further evaluation of the fracture is needed.

· *Bicycle spoke injuries in children:* These injuries are unusual but can occur with entrapment of the leg in the spokes of the bicycle wheel. In a study by Slaar et al [35], if no fracture is noted on ankle radiographs, then no further imaging is warranted. However, if an ankle fracture is present, lower leg imaging may be important to assess the distal tibia and fibula but not the foot.

· *Snowboarder's fracture (lateral talar process or V sign on radiographs):* These fractures may be overlooked on routine radiographs between 40% and 50% of the time [36]. Special attention to this area is recommended in patients with swelling inferior to the lateral malleolus in the appropriate clinical setting to exclude an erroneous diagnosis of a lateral ankle sprain [37]. Lateral inversion stress radiographs may be useful for full evaluation [38].

· *Anterior talofibular ligament view radiograph:* This view may be useful for diagnosis of distal fibular avulsion fractures in children with lateral ankle sprain if not seen on traditional 3-view radiographs. Identification of an occult fibular fracture is noted using this view in 26% of lateral ankle sprain patients [39].

· *The gravity stress view:* This view is more reliable and easier to perform than a manual stress view in supination-external rotation injuries of the ankle with higher suspected incidence of deltoid ligament disruption [40].

Variant 1: Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive: 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.

E. US Ankle

Ultrasound (US) may be useful but is not typically considered the first line of imaging for the evaluation of acute trauma to the ankle with positive OAR [41].

Variant 2: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.

A. Bone scan ankle

Bone scan is not routinely indicated as the first imaging study for evaluation of acute trauma to the ankle in this clinical scenario.

criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.
B. CT Ankle

CT is not routinely indicated as the first imaging study for evaluation of acute trauma to the ankle in this clinical scenario.

Variant 2: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.
C. MRI Ankle

MRI is not routinely indicated as the first imaging study for evaluation of acute trauma to the ankle in this clinical scenario.

Variant 2: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.
D. Radiography Ankle

Radiography is not routinely indicated as the first imaging study for evaluation of acute trauma to the ankle in this clinical scenario.

Variant 2: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)). Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination. Able to walk. Initial imaging.
E. US Ankle

US is not routinely indicated as the first imaging study for evaluation of acute trauma to the ankle in this clinical scenario.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.

OAR should not be used in patients with neurologic abnormality involving the lower leg or those with decreased sensation (eg, diabetics), altered sensorium, or inability to communicate [25,26]. Other possible cautionary or exclusionary scenarios include pregnancy, penetrating trauma, or presence of prior recent outside radiographs on transfer.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
A. Bone scan ankle

Bone scan is not routinely used as the first imaging study for the evaluation of acute trauma to the ankle in

the setting of peripheral neuropathy or other exclusionary criteria.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
B. CT Ankle

The imaging pathway is dependent on the severity of the trauma in patients within this particular clinical scenario. In the high-energy trauma patient or polytrauma patient, fractures and dislocations may be more difficult to identify clinically in the neurologically impaired or neuropathy patient. Occasionally, multidetector CT can be useful as first-line imaging study, particularly for complex injuries such as posterior malleolar fracture and posterior pilon variant fractures, which fall outside the typical classification systems. In a study of 270 patients by Switaj et al [41], the frequency of posterior malleolus fractures and posterior pilon variants was 50% and 20%, respectively; both were found more commonly in older females and diabetic patients. Recent studies of use and implementation of low-dose weight-bearing cone beam CT, particularly in the pediatric population, may be a viable alternative to standard CT studies [42].

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
C. MRI Ankle

MRI is not routinely used as the first imaging study for the evaluation of acute trauma to the ankle in the setting of peripheral neuropathy or neurological disorder or other exclusionary criteria.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
D. Radiography Ankle

In patients with diabetic neuropathy, neurologic compromise of the lower leg, or other exclusionary criteria in which application of the OAR is not possible and fracture is suspected, ankle radiographs are considered the initial imaging study. These patients may have no pain or point tenderness and may walk without discomfort despite fracture because of poor pain proprioception [25]. If there is high suspicion for foreign body, radiographs may also be useful for identification if the foreign body is radiopaque in nature.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
E. Radiography Ankle Stress Views

Ankle stress views are not the first imaging study for the evaluation of acute trauma to the ankle in the setting of peripheral neuropathy or other exclusionary criteria.

Variant 3: Adult or child 5 years of age or older. Acute trauma to the ankle. Exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other). Patient does not meet requirements for evaluation by the Ottawa Ankle Rules. Initial imaging.
F. US Ankle

US is not routinely used as the first imaging study for the evaluation of acute trauma to the ankle in the setting of peripheral neuropathy or other exclusionary criteria. US may be useful as a secondary step in evaluation of foreign bodies or focal fluid collections.

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent

pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.

Acute trauma includes immediate time of injury to <3 weeks, whereas subacute trauma includes 3 weeks to <6 months. The timeframe of this clinical scenario is at the intersection of the late acute and subacute phases, and the OAR criteria can still apply for acute ankle trauma in this setting. Persistent pain may be associated with a radiographically occult fracture, bone contusion, subtle cartilage injury, soft-tissue injury, or foreign body not visible on radiographic examination. Diagnosis is critical in determining appropriate and timely orthopedic fixation/treatment planning [1,5].

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
A. Bone scan ankle

Bone scan is typically not used as the next step in this clinical scenario.

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
B. CT Ankle

CT of the ankle without intravenous (IV) contrast is useful in the trauma setting as the next study to evaluate for radiographically occult fractures and soft-tissue abnormalities. It is rare (<1%) for patients with a large joint effusion but no discernible fracture on radiographic examination, however, CT proved useful in demonstrating a fracture in one-third of cases in one large study [43,44]. Talar fractures (lateral process or comminuted talar body/dome fractures) and fractures associated with the subtalar joint can be difficult to detect on radiographs but are well identified on CT [45,46]. In patients with spiral fractures of the tibia, there is a higher incidence of nondisplaced posterior malleolar fractures that may be missed on radiographic examination [47].

A comparison of multidetector CT versus radiography for ankle fracture detection demonstrated only 87% and 78% sensitivity, respectively, for calcaneal fracture and talar fractures by radiography as compared with CT [48]. Occult osteochondral fractures of the subtalar joint may only be visualized on CT, particularly in patients without dislocation, with fractures involving the posterior facet, with associated massive swelling, or with failure to regain subtalar motion after a period of immobilization [49].

CT with IV contrast is not indicated in this scenario because soft-tissue abnormalities and fluid collections can be identified on noncontrast high-resolution CT studies.

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
C. MRI Ankle

MRI of the ankle without IV contrast is most sensitive for evaluation of occult fractures with associated bone marrow edema patterns, particularly in inversion injuries and persistent lateral ankle pain, as well as presence and extent of soft-tissue injuries [29]. Stress injuries of bone, including those of the weekend warrior, are best depicted by MRI [50].

MRI is the reference standard for ligamentous injury and assessment of stability, which is particularly important in athletes, in whom determination of grade (1, 2, or 3) of syndesmotic ligament, anterior

tibiofibular ligament, and deltoid injuries is critical for treatment planning and return to sport assessment [51]. High-resolution evaluation of the tendons and ligaments allows distinction between tendinopathy, sprain, and partial or complete tears.

Ligament and tendon injuries can occur without fracture on radiography. Grossterlinden et al [52] compared MRI and radiography and showed that 15% of ligamentous injuries (including sprains, partial tears, and complete tears) at the syndesmosis in acute ankle injuries on MRI demonstrated no fracture on radiography. Presence of bone bruise and adjacent soft-tissue edema have shown a higher association with acute ligamentous injuries (anterior talofibular ligament most common) and tendon abnormalities [53,54] in patients with negative radiographs. MRI can also help exclude Salter 1 fractures in the pediatric population [55].

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
D. Radiography Ankle

Repeat radiographs are not typically the next study but may be of use to identify early callous formation at an occult fracture line or possible mineralization at a site of intramuscular hematoma if contusion occurred during trauma. Radiographs with better technique may assist in diagnosis of subtle injuries such as the lateral talar process avulsion, which may erroneously be diagnosed as a lateral ankle sprain [37].

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
E. Radiography Ankle Stress Views

Although ankle stress views are not the typical next best study for this patient group, if there is clinical evidence of instability on physician maneuvers, ankle stress views may be of benefit for identification of occult avulsion injury at ligamentous attachments that may contribute to widening of the joint space on radiographic stress views.

Variant 4: Adult or child 5 years of age or older. Acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks. No exclusionary criteria present. Initial radiographs negative. Next study.
F. US Ankle

US is not typically the next imaging study. US may be useful as a secondary evaluation modality for focused evaluation of underlying soft-tissue injuries and ligaments, with the added benefit of dynamic imaging. This includes focused high-resolution US of the peroneal tendons and the superior peroneal retinaculum [56], stress US (during anterior drawer) to assess joint laxity or chondral avulsion fractures associated with lateral ligament injury in children with negative radiographs [57,58], and potential detection of superficial occult fractures at the base of the fifth metatarsal, lateral malleolus, and malleolus [41].

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.
A. Bone scan ankle

Osteochondral lesions

Bone scan is not the next imaging study in this clinical scenario.

Fractures

Bone scan is not the next imaging study in this clinical scenario. Bone scan may be used in rare setting in polytrauma cases for evaluation of multiple fractures.

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.
B. CT Ankle

Osteochondral lesions

Although MRI is the reference standard, CT is also of utility to identify, locate, and quantify cortical and subcortical involvement or loss as well as presence of intra-articular ossific bodies or associated fractures. In a prospective study of 399 patients, uncontained osteochondral lesion of the talus shoulder, as determined arthroscopically, had a more complicated clinical outcome than those with nonshoulder lesions, confirming the importance of imaging localization for clinical outcome [59]. An inverted osteochondral fracture of the lateral talus (lateral, inverted, fracture talus, also known as the LIFT lesion) can occur after twisting injury to the ankle. Initial radiographs should be followed by CT and MRI [60,61]. These lesions are treated successfully with combined open approach and arthroscopy.

Fractures

CT is the first-line imaging study after radiographs to determine extent, displacement, comminution, intra-articular extension, associated injuries, and potential classification of fractures [48]. This is particularly important in subtalar, calcaneal, and talar fractures because of the complex anatomy and in high-impact polytrauma or complex comminuted injuries in which multiplanar CT imaging is recommended to help direct the preoperative planning evaluation process [62].

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.
C. MRI Ankle

Osteochondral lesions

MRI without IV contrast is considered the study of choice for assessment of cartilage abnormalities and bone contusions related to acquired osteochondral lesion, particularly in patients with symptoms of persistent pain, stiffness, locking, clicking, and ankle swelling [22,55-57,63]. Although radiographs and CT depict ossific fragments and fracture lines, cartilage abnormalities and bone contusions related to osteochondral lesion are best seen on MRI. Seventy percent of ankle fractures and 50% of ankle sprains have been shown to result in some variation of cartilage injury [57,58,61,64].

Fractures

Although CT is more commonly used as the next step in fracture assessment in known fractures, MRI can

be useful as a follow-up imaging modality for assessment of associated bone marrow contusions, stress injuries, or fractures [65]. MRI is especially important in fracture sites such as the talus, which are at higher risk for osteonecrosis. MRI is highly accurate for associated soft-tissue abnormalities including tendon entrapment/dislocation and for ligamentous injuries [66].

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.
D. Radiography Ankle Broden's View

The Broden view is a supine flexed knee view with 30° to 45° internal rotation that can be used for specific improved evaluation of the lateral process fracture of the talus (commonly known as snowboarder's fracture). It may be of use when further evaluation of the talar fracture is needed.

Variant 5: Adult or child 5 years of age or older. Acute trauma to the ankle. No exclusionary criteria present. Radiographs demonstrate fracture or potential osteochondral injury. Next study.
E. US Ankle

Osteochondral lesion

US is not the next step in this clinical scenario.

Fractures

US has been shown to be useful for identification of lateral malleolar, medial malleolar, and fifth metatarsal fractures [41] but is not considered a first-line assessment tool or next imaging study in this clinical scenario.

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.

Lateral sprain is more common than medial strain, with the anterior talofibular ligament most commonly torn. High sprain and fractures are more common in high-collision sport injuries [60], with higher incidence of ankle injuries during winter months [67] and increased incidence in military recruits [68]. Inversion injuries of the ankle account for 25% of musculoskeletal system injuries and 50% of all sports-related injuries [1].

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
A. Bone scan ankle

Bone scan is not routinely the next line of imaging in this clinical scenario.

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
B. CT Ankle

CT is useful for evaluation of dislocation and can be used to detect syndesmotic injuries, although MRI is better for soft-tissue evaluation. Nault et al [69] validated CT scan measurements that can identify syndesmotic injuries seen on MRI (retrospective study of MRI and CT) as a result of modification of distal

tibiofibular relationship after a mild syndesmotic injury. The transsyndesmotic ankle fracture dislocation ("logsplitter injury") results from high-energy trauma disruption of the syndesmosis with axial displacement of the talus into the distal tibia and fibula with or without fractures of the plafond, which can be noted on CT [70].

Rare pantalar dislocations without associated talar or other fracture can be assessed on CT or MRI and have high rates of osteonecrosis, osteoarthritis, and infection [71].

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
C. MRI Ankle

MRI is the reference standard for ligamentous injury and assessment of stability, which is particularly important in athletes, in whom determination of grade (1, 2, or 3) of syndesmotic ligament, anterior tibiofibular ligament, and deltoid injuries is critical for treatment planning and return to sport assessment [51].

Ligamentous injuries can occur without fracture on radiography. Grossterlinden et al [52] compared MRI and radiography and showed that 15% of ligamentous injuries (including sprains, partial tears, and complete tears) at the syndesmosis in acute ankle injuries on MRI demonstrated no fracture on radiography.

Rare pantalar dislocations without associated talar or other fracture can be assessed on CT or MRI and have high rates of osteonecrosis, osteoarthritis, and infection [71].

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
D. Radiography Ankle Stress Views

Stress radiographs may be useful in assessing syndesmotic instability, particularly in supination external rotation ankle injuries according to the Lauge-Hansen classification. Lee et al [72] noted that tibiotalar tilt angle and anterior tibiofibular space measurements were affected when the anterior tibiofibular and posterior talofibular ligaments were injured (confirmed on MRI) in 299 patients. Lateral stress testing with widening of the tibiofibular clear space has been shown to be an indicator of syndesmotic injury, with the traditional external rotation stress test shown to be a poor indicator when the deltoid ligament is injured [73].

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
E. Radiography Leg

Maisonneuve fracture (syndesmotic injury of the ankle in combination with a proximal fibular fracture) may be overlooked as a result of lack of pain at the fibula. Careful palpation of the proximal fibula should be performed with radiographic evaluation of the entire tibia and fibular if focal tenderness is present [74].

Variant 6: Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.
F. US Ankle

US is not typically the next line of evaluation of syndesmotic injuries. Although some studies have suggested focused US could be beneficial for ligamentous evaluation, others have shown limited utility in lateral ankle ligament sprains [75].

Summary of Highlights

Variant 1: Ankle radiographs are usually appropriate for the initial imaging of patients 5 years of age or older with acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks with no exclusionary criteria present and the OAR are positive: 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.

Variant 2: Imaging is usually not appropriate for patients 5 years of age or older with acute trauma to the ankle when the patient is able to walk and there are no exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)) and the OAR are negative: No point tenderness over the malleoli, talus, or calcaneus on physical examination.

Variant 3: Ankle radiographs are usually appropriate for the initial imaging of patients 5 years of age or older with acute trauma to the ankle when exclusionary criteria are present (eg, neurologic disorder, neuropathy, or other) and the patient does not meet requirements for evaluation by the OAR.

Variant 4: MRI ankle without IV contrast or CT ankle without IV contrast are usually appropriate for patients 5 years of age or older with acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks that had negative initial radiographs and no exclusionary criteria are present. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Variant 5: CT ankle without IV contrast or MRI ankle without IV contrast are usually appropriate for patients 5 years of age or older with acute trauma to the ankle that had radiographs demonstrating fracture or potential osteochondral injury and have no exclusionary criteria present. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). CT ankle without IV contrast is more likely to be performed for known fracture evaluation with MRI ankle without IV contrast more likely to be performed for potential osteochondral injury evaluation.

Variant 6: MRI ankle without IV contrast or radiography ankle stress views or radiography leg or CT ankle without IV contrast are usually appropriate for patients 5 years of age or older with acute trauma to the ankle whose initial radiographs were negative for osseous injury or had radiographs or physical examination demonstrating alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). CT ankle without IV contrast is more likely to be performed for dislocation injuries, with MRI ankle without IV contrast typically used in evaluation of syndesmotic/ligamentous injury. Proximal fibular tenderness on clinical exam should lead to radiography of the leg to evaluate for Maisonneuve fracture.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting

documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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, because of both 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 with 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 (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring

physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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