American College of Radiology
ACR Appropriateness Criteria®
Chronic Ankle Pain

Variant 1: **Chronic ankle pain. Initial imaging.**

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

Variant 2: **Chronic ankle pain. Multiple sites of degenerative joint disease in the hindfoot detected by ankle radiographs. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
Image-guided anesthetic injection ankle and hindfoot	May Be Appropriate	Varies
MRI ankle and hindfoot without IV contrast	May Be Appropriate	O
CT ankle and hindfoot without IV contrast	May Be Appropriate	☢
CT ankle and hindfoot with IV contrast	Usually Not Appropriate	☢
CT ankle and hindfoot without and with IV contrast	Usually Not Appropriate	☢
MRI ankle and hindfoot without and with IV contrast	Usually Not Appropriate	O
Bone scan hindfoot/ankle	Usually Not Appropriate	☢☢☢
US ankle and hindfoot	Usually Not Appropriate	O
CT arthrography ankle and hindfoot	Usually Not Appropriate	☢
MR arthrography ankle and hindfoot	Usually Not Appropriate	O
Radiographic arthrography ankle and hindfoot	Usually Not Appropriate	☢

Variant 3: **Chronic ankle pain. Ankle radiographs normal, suspected osteochondral lesion. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
CT arthrography ankle	May Be Appropriate	☢
MR arthrography ankle	May Be Appropriate	O
Bone scan with SPECT or SPECT/CT ankle	May Be Appropriate (Disagreement)	☢☢☢
CT ankle without IV contrast	May Be Appropriate	☢
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	☢
Radiography ankle stress views	Usually Not Appropriate	☢
US ankle	Usually Not Appropriate	O
Radiographic arthrography ankle	Usually Not Appropriate	☢
Image-guided anesthetic injection ankle	Usually Not Appropriate	Varies

Variant 4: **Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected tendon abnormality. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
US ankle	Usually Appropriate	O
US-guided anesthetic injection ankle tendon sheath	May Be Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
Radiography ankle stress views	Usually Not Appropriate	☢
Bone scan ankle	Usually Not Appropriate	☢☢☢
CT ankle without IV contrast	Usually Not Appropriate	☢
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
CT arthrography ankle	Usually Not Appropriate	☢
MR arthrography ankle	Usually Not Appropriate	O
Fluoroscopy tenography ankle	Usually Not Appropriate	☢
Radiographic arthrography ankle	Usually Not Appropriate	☢

Variant 5: **Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected ankle instability. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
MR arthrography ankle	Usually Appropriate	O
US ankle	May Be Appropriate	O
Radiography ankle stress views	May Be Appropriate	☢
CT arthrography ankle	May Be Appropriate	☢
MRI ankle without and with IV contrast	Usually Not Appropriate	O
Bone scan ankle	Usually Not Appropriate	☢☢☢
CT ankle without IV contrast	Usually Not Appropriate	☢
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
Radiographic arthrography ankle	Usually Not Appropriate	☢
Image-guided anesthetic injection ankle	Usually Not Appropriate	Varies

Variant 6: **Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected ankle impingement syndrome. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
MR arthrography ankle	May Be Appropriate	O
CT ankle without IV contrast	May Be Appropriate	☢
CT arthrography ankle	May Be Appropriate	☢
Image-guided anesthetic injection ankle	May Be Appropriate (Disagreement)	Varies
US ankle	May Be Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
3-phase bone scan with SPECT or SPECT/CT ankle	Usually Not Appropriate	☢☢☢
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
Radiography ankle stress views	Usually Not Appropriate	☢
Radiographic arthrography ankle	Usually Not Appropriate	☢

Variant 7: **Chronic ankle pain. Ankle radiographs normal, pain of uncertain etiology. Next study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI ankle without IV contrast	Usually Appropriate	O
CT ankle without IV contrast	May Be Appropriate	☢
Bone scan with SPECT or SPECT/CT ankle	May Be Appropriate (Disagreement)	☢☢☢
Image-guided anesthetic injection ankle	May Be Appropriate	Varies
US ankle	May Be Appropriate	O
CT ankle with IV contrast	Usually Not Appropriate	☢
CT ankle without and with IV contrast	Usually Not Appropriate	☢
CT arthrography ankle	Usually Not Appropriate	☢
MR arthrography ankle	Usually Not Appropriate	O
MRI ankle without and with IV contrast	Usually Not Appropriate	O
Radiography ankle stress views	Usually Not Appropriate	☢
Radiographic arthrography ankle	Usually Not Appropriate	☢

CHRONIC ANKLE PAIN

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Summary of Literature Review

Introduction/Background

Ankle pain is considered chronic when symptoms persist >6 weeks. Chronic ankle pain can be caused by a variety of osseous or soft-tissue abnormalities, either alone or in combination. For assessing chronic ankle pain, there are multiple imaging options, including radiography, stress radiography, computed tomography (CT) radionuclide bone scanning, ultrasound (US), magnetic resonance imaging (MRI), and various injection procedures. Injection procedures include arthrography, CT arthrography, MR arthrography, and diagnostic injection with anesthetic agents. Although there are numerous causes for chronic ankle pain, common etiologies include osteoarthritis, osteochondral injury, tendon abnormalities, ligament abnormalities and instability, and impingement.

Overview of Imaging Modalities

Radiography

Radiographs can provide information about the osseous and soft-tissue structures about the ankle. Routine radiographs of the ankle typically include anteroposterior, lateral, and mortise views, the latter obtained by internally rotating the foot 15 to 20 degrees. Stress radiographs can be used to assess ankle instability [1,2]; however, some have questioned their accuracy [3,4].

CT

CT is not routinely used as a first-line imaging tool in chronic ankle pain, but it is more sensitive than radiographs, particularly for osseous abnormalities [5]. CT arthrography may be more accurate than MR arthrography for the identification of osteochondral abnormalities [6].

Bone Scan

Conventional planar bone scintigraphy can assess osseous pathology. More recently, single-photon emission computed tomography (SPECT) combined with CT has been shown to provide additional information compared with clinical diagnosis and conventional bone scintigraphy for the evaluation of impingement syndromes and soft-tissue pathology [7]. In addition, SPECT/CT abnormalities have been shown to significantly correlate with pain in osteochondral lesions [8].

US

US can be used to evaluate for soft-tissue abnormalities, including tendon and ligament tears. In inflammatory arthritis, it can help in the assessment of disease activity and severity as well as detect subclinical pathology in early disease or after treatment [9]. US is ideal for dynamic assessment of peroneal tendon instability [10] and can be used to guide interventions [11]. Compared with some other modalities, US is less prone to artifacts, such as susceptibility, motion, magic angle, and streak artifact, but dynamic assessment may be limited in cases of pain.

MRI

MRI is the imaging test that globally evaluates all anatomic structures, including ligaments, tendons, cartilage, and bone [12,13]. Most studies have shown that MRI is highly accurate for evaluation of ligament, tendon, and

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osteochondral abnormalities [14-16], although one study found statistically significant lower sensitivity for these abnormalities on MRI as compared to arthroscopy [17]. MRI can identify synovitis and impingement lesions, which can contribute to patient symptoms [18].

Discussion of Procedures by Variant

Variant 1: Chronic ankle pain. Initial imaging.

Radiography

Radiography should be considered as the initial imaging study. Radiographs may reveal osteoarthritis, calcified or ossified intra-articular bodies, osteochondral abnormalities, stress fractures, or evidence of prior trauma. Ankle effusions may also be identified in the anterior ankle joint recess by radiography with 53% to 74% accuracy [19]. They are often associated with ligamentous injury or fracture [19]. The presence of ossific fragments can indicate ligamentous injury or retinaculum avulsion [20], whereas periostitis can occur adjacent to tenosynovitis. Radiographs can also identify synovial osteochondromatosis and erosions from chronic synovitis.

CT

CT is not routinely used as the first study for the evaluation of chronic ankle pain.

MRI

MRI is not routinely used as the first study for the evaluation of chronic ankle pain.

US

US is not routinely used as the first study for the evaluation of chronic ankle pain.

Bone Scan

Bone scan is not routinely used as the first study for the evaluation of chronic ankle pain.

Variant 2: Chronic ankle pain. Multiple sites of degenerative joint disease in the hindfoot detected by ankle radiographs. Next study.

When multiple sites of osteoarthritis are present, it may be important to determine which joint is the cause of symptoms.

Image-guided Anesthetic Injection

Several reports have indicated the effectiveness of fluoroscopic, CT, or US-guided anesthetic [11] with or without corticosteroid injection of joints to identify a source of pain, which aids in surgical planning [21-25].

MRI

When degenerative changes of the ankle joint are diagnosed based on radiographs, MRI may be considered as the next best examination to evaluate cartilage integrity, bone marrow, and associated soft tissues, such as ligaments and tendons, if these injuries are clinically suspected [13-15].

CT

CT without contrast may be helpful to visualize subchondral cysts [5].

US

US is not routinely used for the evaluation of degenerative joint disease.

Bone Scan

Bone scan is not routinely used for the evaluation of degenerative joint disease.

Arthrography

Arthrography is not routinely used for the evaluation of degenerative joint disease.

MR Arthrography

MR arthrography is not routinely used for the evaluation of degenerative joint disease.

CT Arthrography

CT arthrography is not routinely used for the evaluation of degenerative joint disease.

Variant 3: Chronic ankle pain. Ankle radiographs normal, suspected osteochondral lesion. Next study.

Osteochondral injuries may involve the talar dome and, less commonly, the tibial plafond and tarsal navicular bone [5,26,27]. If this injury is associated with fracture, osseous cyst, or osteochondral defect, radiography may show the abnormality; however, radiography often fails to show the extent of the osteochondral injury and will be initially negative if the injury is limited to the articular hyaline cartilage. One multimodality study [5] showed that 41% of osteochondral abnormalities of the ankle were missed on radiography.

MRI

In one multimodality study, MRI performed similarly to arthroscopy for the evaluation of osteochondral abnormalities of the ankle [5]. Although MRI had the highest sensitivity (96%), it was less specific than CT [5]. MRI is effective in determining osteochondral injury instability (sensitivity 97%), most commonly appearing as a high signal line deep to the osteochondral lesion on T2-weighted images or less commonly as a focal defect, an articular fracture, or an adjacent cyst [28]. MRI has also been used to stage these lesions preoperatively with an accuracy of 81% [29] and to assess osteochondral abnormalities after cartilage repair [30]. Although MRI may be less reliable than CT arthrography for talar cartilaginous lesions (accuracy between 76% to 88%) [6], high-resolution MRI using a microscopy coil (eg, a 4-cm receive-only surface coil) can assist in detecting small, clinically relevant features of talar osteochondral lesions that may be missed on standard MRI, including osteochondral junction separation due to focal collapse of the subchondral bone, reparative cartilage hypertrophy, and bone separation in the absence of cartilage fracture [31].

CT Arthrography

The introduction of contrast into the ankle joint prior to CT will outline a cartilage surface defect, assisting in lesion detection and assessment for instability. One study comparing CT arthrography and MR arthrography for talar cartilaginous lesions found an accuracy between 76% to 88% using MR arthrography compared to 90% to 92% for CT arthrography, suggesting that CT arthrography may be more reliable [6].

MR Arthrography

The introduction of contrast into the ankle joint prior to MRI will outline a cartilage surface defect, assisting in lesion detection and assessment for instability. One study comparing CT arthrography and MR arthrography for talar cartilaginous lesions found an accuracy between 76% to 88% using MR arthrography compared to 90% to 92% for CT arthrography, suggesting that CT arthrography may be more reliable [6].

CT

In one multimodality study, CT (noncontrast, multidetector with multiplanar reformatted images) performed similarly to arthroscopy for the evaluation of osteochondral abnormalities of the ankle [5]. However, CT was more specific (99%) but less sensitive then MRI [5].

Bone Scan with SPECT or SPECT/CT

When osteochondral injuries are associated with fracture, osseous cyst, or osteochondral defect, bone scans may show the abnormality. One study evaluating the role of SPECT/CT in assessing osteochondral defects in the ankle found that this study affected the surgeon's ultimate decision regarding treatment in 48% to 52% of cases, as it allowed for improved evaluation of the subchondral bone and subchondral bone plate [32]. SPECT/CT abnormalities have also been shown to significantly correlate with pain in the setting of osteochondral lesions [8] and to precisely localize the painful regions in the setting of multiple lesions [33,34].

US

US is not routinely used for the evaluation of osteochondral lesions in the ankle.

Radiography

Stress views are not routinely used for the evaluation of osteochondral lesions in the ankle.

Arthrography

Arthrography is not routinely used for the evaluation of osteochondral lesions in the ankle.

Image-guided Anesthetic Injection

Image-guided anesthetic injections may be helpful to assess whether an osteochondral lesion in the ankle is the source of the patient's pain [8].

Variant 4: Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected tendon abnormality. Next study.

Possible tendon abnormalities include tenosynovitis, tendinopathy, tendon tear (partial or complete), and tendon subluxation or dislocation. Both MRI and US can effectively demonstrate ankle tendon abnormalities, although US results are more dependent on operator skill and expertise [10,35]. For the assessment, it is assumed the procedure is performed and interpreted by an expert.

US
US can be used to evaluate for soft-tissue abnormalities, including tendon and ligament tears. It has been shown to produce similar results as MRI in diagnosing ankle tendon tears, although US results are more dependent on operator skill and expertise [10,35]. In this case, it is assumed that the procedure is performed and interpreted by an expert. One study showed that it had a sensitivity of 100% and an accuracy of 93% compared to surgical findings [36]. With regard to the tibialis posterior tendon, one study evaluating tendon pathology showed that US was slightly less sensitive than MRI; however, this difference did not significantly affect clinical management [37]. One study using US showed 100% sensitivity and 90% accuracy in diagnosing peroneal tendon tears [38]; suggesting that US may be more useful than MRI. With regard to chronic Achilles tendinopathy, US detected 21 of 26 cases of tendinosis and partial rupture [39], and another study showed that US can differentiate full-thickness from partial-thickness Achilles tears with 92% accuracy [40]. In addition to the diagnostic capabilities of US, when a tendon abnormality is detected, it can be used to guide interventions such as concurrent performance of US-guided intrasheath anesthetic injections [11]. It can also be used for direct intratendinous biologic injection and dry needling [41-43].

One significant advantage of US is in the dynamic assessment for tendon subluxation (including intrasheath subluxation) and dislocation, with a reported positive predictive value of 100% compared to surgical findings [44,45].

US-guided sheath injections are more accurate than palpation guided and allow for precise positioning of the needle tip in the sheath rather than the tendon substance because a large volume intratendinous injection of corticosteroids or local anesthetic can result in a split tear [46].

US can detect intratendinous tophi in gout, enthesitis of the Achilles tendon or plantar fascia in spondyloarthritis, and tenosynovitis in spondyloarthritis and rheumatoid arthritis [47].

MRI
It is generally accepted that MRI can achieve high sensitivities (>90%) in diagnosing ankle tendon tears [16]. Regarding tibialis posterior tendon, MRI is more sensitive than US; however, this difference did not significantly affect clinical management [37]. With regard to peroneal tendinopathy and tendon tear, one study found the sensitivities and specificities of MRI to be 83.9% and 74.5%, respectively, for tendinopathy and 54.5% and 88.7%, respectively, for tendon tears [48]. With regard to chronic Achilles tendinopathy, MRI detected 26 of 27 cases of tendinosis and partial rupture [39]. MRI reported a 66% accuracy rate for assessment for tendon subluxation and dislocation [44,45]. MRI evidence of peroneal tendon pathology should be treated with caution because up to 34% of asymptomatic patients may have a tear of the peroneus brevis tendon [49]. One study showed that MRI evidence of peroneal tendon pathology had a 48% positive predictive value for clinical findings, highlighting the importance of clinical examination [50].

Image-guided Anesthetic Injection
In addition to the diagnostic capabilities of US, when a tendon abnormality is detected, a fluoroscopic or US-guided intrasheath anesthetic injection can be concurrently performed [11].

Tenography
Diagnostic and therapeutic ankle tenography can also be considered for evaluation, with one study reporting that 47% of patients had prolonged relief of symptoms [51].

CT
CT is not routinely used for the evaluation of suspected tendon abnormality.

Bone Scan
Bone scan is not routinely used for the evaluation of suspected tendon abnormality.

CT Arthrography
CT arthrography is not routinely used for the evaluation of suspected tendon abnormality.

MR Arthrography
MR arthrography is not routinely used for the evaluation of suspected tendon abnormality.

Arthrography
Arthrography is not routinely used for the evaluation of suspected tendon abnormality.

Radiography

Stress views are not routinely used for the evaluation of suspected tendon abnormality.

Variant 5: Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected ankle instability. Next study.

In the absence of findings on routine radiography, imaging options to evaluate ligamentous integrity include stress radiography, MRI, MR arthrography, CT arthrography, and US.

MRI

One study evaluating anterior talofibular ligament injury demonstrated a diagnostic accuracy of 97% for MRI when compared to arthroscopic findings. Additionally, MRI identified the exact location of the injury in 93% of the cases [15]. Comparing MRI with arthroscopy, studies have shown a range of accuracies of chronic lateral ligament tearing (either partial or complete), ranging from 77% to 92% for the anterior talofibular ligament and 88% to 92% for the calcaneofibular ligament [14,52]. For the evaluation of deep deltoid ligament tears, MRI is both sensitive and specific compared with arthroscopy, with reported values of 96% and 98%, respectively [53].

With regard to tears of the tibiofibular ligaments of the tibiofibular syndesmosis, MRI has a reported accuracy of 100% [54]. Additionally, MRI can also demonstrate interosseous membrane tears [55]. MRI offers the advantage of evaluating for injuries associated with or mimicking lateral instability that may not be diagnosed on stress radiography such as tenosynovitis, tendon injury, and osteochondral lesions [56]. MRI may also be used to evaluate the ankle after lateral ligament reconstruction [57].

MR Arthrography

MR arthrography can be helpful for the assessment of chronic ankle instability due to lateral collateral ligament injuries [12].

US

One study evaluating anterior talofibular ligament injury demonstrated a diagnostic accuracy of 91% for US when compared to arthroscopic findings. Additionally, US identified the exact location of the injury in 63% of cases [15]. Another study comparing US and CT arthrography for the diagnosis of anterior talofibular ligament injury showed an accuracy of 61% using US and 71% for CT arthrography [58]. US also has the dynamic capability of stressing the ligament and looking for laxity or frank separation of the injured ligament [1,59].

With regard to interosseous membrane tears, US has a proven sensitivity of 89% and specificity of 94.5% in diagnosing interosseous membrane tears shown at surgery [55,60].

Radiography

Stress radiographs can be used to assess ankle instability [1,2]; however, some have questioned their accuracy [3,4]. One study evaluating anterior talofibular ligament injury demonstrated a diagnostic accuracy of 67% for stress radiography [15]. Oae et al [15] compared stress radiography to arthroscopic findings and found the former has an accuracy of 67% for evaluating anterior talofibular ligament injuries. Subtalar stress radiography using forced dorsiflexion and supination [4] or talar rotation [61] can be used to evaluate subtalar laxity.

CT Arthrography

CT arthrography showed an accuracy of 71% for diagnosing anterior talofibular ligament injury [58].

CT

CT is not routinely used for the evaluation of ligamentous integrity.

Arthrography

Arthrography is not routinely used for the evaluation of ligamentous integrity.

Image-guided Anesthetic Injection

Image-guided anesthetic injection is not routinely used for the evaluation of ligamentous integrity.

Bone Scan

Bone scan is not routinely used for the evaluation of ligamentous integrity.

Variant 6: Chronic ankle pain. Ankle radiographs normal or nonspecific, suspected ankle impingement syndrome. Next study.

Imaging can also be used to diagnose ankle impingement syndromes, which can occur in the anterolateral, anterior, anteromedial, posteromedial, and posterior aspects of the ankle joint [62-71].

MR Arthrography
MR arthrography has been found to be an accurate method for assessing both anterolateral and anteromedial impingement with the advantage of joint capsule distention by intra-articular contrast injection [68,69].

US
One study involving anterolateral ankle impingement compared US to arthroscopic findings. The study found US had a sensitivity and specificity of 77% and 57%, respectively [70]. US also showed abnormal soft tissues in anterolateral impingement, with a reported accuracy of 100% in one study [72].

MRI
Studies on the accuracy of MRI in diagnosing anterolateral impingement syndrome have drawn varying conclusions, which may be related to varying MRI magnet strengths and inconsistent protocols [73]. Comparing MRI with surgical findings, studies have shown sensitivities between 75% to 83% and specificity between 75% to 100% for the diagnosis of anterolateral impingement [73,74].

One study found that, when compared with arthroscopy, fat-suppressed, IV contrast-enhanced, 3-D gradient-recalled echo imaging was sensitive for the evaluation of synovitis of the ankle associated with trauma (92%), whereas it was specific for soft-tissue impingement evaluation (97%) when the ankle was divided into four compartments: the anterolateral gutter, anteromedial gutter, anterior recess, and posterior recess [75].

MRI is useful in confirming the diagnosis, evaluating patients with an uncertain clinical diagnosis, and planning surgery. Additionally, it can help exclude other pathologic entities that may mimic or coexist with impingement syndromes. However, MRI features supportive of impingement may be present in asymptomatic individuals, and an accurate diagnosis requires careful correlation of imaging features findings with clinical findings [76]. There are only limited reports on the use of MRI for the other forms of ankle impingement syndrome, so its accuracy in these conditions is not well established [62,64,67,68].

CT Arthrography
One study involving anterolateral ankle impingement compared CT arthrography to arthroscopic findings. The study found that CT arthrography had a sensitivity and specificity of 97% and 71%, respectively [77].

Image-guided Anesthetic Injection
Fluoroscopic or US-guided injections have been shown as an effective treatment for some ankle impingement syndromes [78,79].

Bone Scan with SPECT or SPECT/CT
Recently, SPECT combined with CT has been shown to provide additional information compared with clinical diagnosis and conventional bone scintigraphy for the evaluation of impingement syndromes and soft-tissue pathology [7]. One study found that SPECT/CT provided information not suspected on clinical diagnosis in 56% of cases with impingement syndromes or soft-tissue pathology [7].

CT
CT may be useful for depiction of osseous causes of impingement, such as chronic abnormalities between the talus and an os trigonum or fractures of the lateral tubercle of the talus or os trigonum [62].

Arthrography
Arthrography is not routinely used for the evaluation of ankle impingement syndromes.

Radiography
Stress views are not routinely used for the evaluation of ankle impingement syndromes.

Variant 7: Chronic ankle pain. Ankle radiographs normal, pain of uncertain etiology. Next study.

When chronic ankle pain is of unclear etiology, normal ankle radiographs can be followed by other imaging tests, primarily directed by clinical findings.

MRI
If the patient has a focal soft-tissue abnormality, MRI can be considered. Peripheral nerve-related symptoms can be evaluated with US or MRI; however, US has the benefit of higher resolution. If symptoms are believed to originate from osseous structures, MRI can be considered if there is concern for an initially missed fracture [80]. MRI is effective in detecting osseous stress injuries [81]. Overall, MRI is the imaging test that globally evaluates all anatomic structures, including bone marrow [13,82].

US
US is best used as a focal examination and should not be used for comprehensive evaluation of the ankle when no particular pathology is suspected. If the patient has a focal soft-tissue abnormality, US can be considered. Peripheral nerve-related symptoms can be evaluated with US or MRI; however, US has the benefit of higher resolution. US with dynamic evaluation should be considered when symptoms are only present during specific movements or positions [83,84].

CT
If symptoms are believed to originate from osseous structures, CT can be considered if there is concern for an initially missed fracture [80]. CT has been shown to be superior to radiography for fracture detection [85].

Bone Scan with SPECT or SPECT/CT
SPECT/CT is an emerging imaging modality for evaluation of ankle pathology and can detect osteochondral lesions, osteoarthritis, tarsal coalition, occult fractures, or painful accessory bones [86].

Arthrography
Arthrography is not routinely used for the evaluation of pain of unknown etiology in the ankle.

CT Arthrography
CT arthrography is not routinely used for the evaluation of pain of unknown etiology in the ankle.

MR Arthrography
MR arthrography is not routinely used for the evaluation of pain of unknown etiology in the ankle.

Image-guided Anesthetic Injection
US-guided nerve blocks have been reported to be helpful for diagnostic purposes and to plan for surgical or procedural intervention [87-89].

Radiography
Stress views are not routinely used for the evaluation of pain of unknown etiology in the ankle.

Other Causes of Chronic Ankle Pain

Tarsal tunnel syndrome
Tarsal tunnel syndrome can also be a cause of chronic ankle pain. See the ACR Appropriateness Criteria® topic on "Chronic Foot Pain" [90].

Suspected stress fracture
Stress fractures can also be a cause of chronic ankle pain. See the ACR Appropriateness Criteria® topic on "Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae" [91].

Tarsal coalition
Tarsal coalition can also be a cause of chronic ankle pain. See the ACR Appropriateness Criteria® topic on "Chronic Foot Pain" [90].

Suspected tumor
Tumors can also be a cause of chronic ankle pain. See the ACR Appropriateness Criteria® topics on "Primary Bone Tumors" [92], "Metastatic Bone Disease" [93], and "Soft-Tissue Masses" [94].

Inflammatory arthritis or crystal deposition
Inflammatory arthritis or crystal deposition can also be a cause of chronic ankle pain. See the ACR Appropriateness Criteria® topic on "Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis" [95].

Summary of Recommendations

- Radiograph of the ankle is the most appropriate initial imaging study.
- Image-guided anesthetic injection ankle and hindfoot, MRI ankle and hindfoot without IV contrast, or CT ankle and hindfoot without IV contrast may be appropriate as the next study for degenerative joint disease in the hindfoot detected by ankle radiographs.
- MRI ankle without IV contrast should be the next imaging study when ankle radiographs are normal for suspected osteochondral lesion.
- Either MRI ankle without IV contrast or US ankle should be ordered when tendon abnormality is suspected and ankle radiographs are normal.
- Either MRI ankle without IV contrast or MR arthrography of the ankle should be ordered when ankle instability is suspected and ankle radiographs are normal.
- MRI ankle without IV contrast should be ordered when ankle impingement syndrome is suspected and ankle radiographs are normal.
- MRI ankle without IV contrast should be ordered as the next study after radiographs when there is pain of uncertain etiology and ankle radiographs are normal.

Summary of Evidence

Of the 96 references cited in the *ACR Appropriateness Criteria® Chronic Ankle Pain* document, 5 are categorized as therapeutic references including 1 well-designed study and 3 good-quality studies. Additionally, 91references are categorized as diagnostic references including 1 well-designed study, 10 good-quality studies, and 41 quality studies that may have design limitations. There are 40 references that may not be useful as primary evidence.

The 96 references cited in the *ACR Appropriateness Criteria® Chronic Ankle Pain* document were published from 1988-2017.

Although there are references that report on studies with design limitations, 15 well-designed or good-quality studies provide good evidence.

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, 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 [96].

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.

References

1. Cho JH, Lee DH, Song HK, Bang JY, Lee KT, Park YU. Value of stress ultrasound for the diagnosis of chronic ankle instability compared to manual anterior drawer test, stress radiography, magnetic resonance imaging, and arthroscopy. *Knee Surg Sports Traumatol Arthrosc.* 2016;24(4):1022-1028.
2. Dowling LB, Giakoumis M, Ryan JD. Narrowing the normal range for lateral ankle ligament stability with stress radiography. *J Foot Ankle Surg.* 2014;53(3):269-273.
3. Hoffman E, Paller D, Koruprolu S, et al. Accuracy of plain radiographs versus 3D analysis of ankle stress test. *Foot Ankle Int.* 2011;32(10):994-999.
4. Tourne Y, Besse JL, Mabit C. Chronic ankle instability. Which tests to assess the lesions? Which therapeutic options? *Orthop Traumatol Surg Res.* 2010;96(4):433-446.
5. Verhagen RA, Maas M, Dijkgraaf MG, Tol JL, Krips R, van Dijk CN. Prospective study on diagnostic strategies in osteochondral lesions of the talus. Is MRI superior to helical CT? *J Bone Joint Surg Br.* 2005;87(1):41-46.
6. Schmid MR, Pfirrmann CW, Hodler J, Vienne P, Zanetti M. Cartilage lesions in the ankle joint: comparison of MR arthrography and CT arthrography. *Skeletal Radiol.* 2003;32(5):259-265.
7. Chicklore S, Gnanasegaran G, Vijayanathan S, Fogelman I. Potential role of multislice SPECT/CT in impingement syndrome and soft-tissue pathology of the ankle and foot. *Nucl Med Commun.* 2013;34(2):130-139.
8. Wiewiorski M, Pagenstert G, Rasch H, Jacob AL, Valderrabano V. Pain in osteochondral lesions. *Foot Ankle Spec.* 2011;4(2):92-99.
9. Micu MC, Nestorova R, Petranova T, et al. Ultrasound of the ankle and foot in rheumatology. *Med Ultrason.* 2012;14(1):34-41.

10. Lee SJ, Jacobson JA, Kim SM, et al. Ultrasound and MRI of the peroneal tendons and associated pathology. *Skeletal Radiol.* 2013;42(9):1191-1200.
11. Yablon CM. Ultrasound-guided interventions of the foot and ankle. *Semin Musculoskelet Radiol.* 2013;17(1):60-68.
12. Nazarenko A, Beltran LS, Bencardino JT. Imaging evaluation of traumatic ligamentous injuries of the ankle and foot. *Radiol Clin North Am.* 2013;51(3):455-478.
13. Weishaupt D, Schweitzer ME. MR imaging of the foot and ankle: patterns of bone marrow signal abnormalities. *Eur Radiol.* 2002;12(2):416-426.
14. Joshy S, Abdulkadir U, Chaganti S, Sullivan B, Hariharan K. Accuracy of MRI scan in the diagnosis of ligamentous and chondral pathology in the ankle. *Foot Ankle Surg.* 2010;16(2):78-80.
15. Oae K, Takao M, Uchio Y, Ochi M. Evaluation of anterior talofibular ligament injury with stress radiography, ultrasonography and MR imaging. *Skeletal Radiol.* 2010;39(1):41-47.
16. Rosenberg ZS, Cheung Y, Jahss MH, Noto AM, Norman A, Leeds NE. Rupture of posterior tibial tendon: CT and MR imaging with surgical correlation. *Radiology.* 1988;169(1):229-235.
17. Cha SD, Kim HS, Chung ST, et al. Intra-articular lesions in chronic lateral ankle instability: comparison of arthroscopy with magnetic resonance imaging findings. *Clin Orthop Surg.* 2012;4(4):293-299.
18. Singleton TJ, Hutchinson B, Ford L. Arthroscopic treatment of ankle osteochondral lesions. *Clin Podiatr Med Surg.* 2011;28(3):481-490.
19. Karchevsky M, Schweitzer ME. Accuracy of plain films, and the effect of experience, in the assessment of ankle effusions. *Skeletal Radiol.* 2004;33(12):719-724.
20. Ketz JP, Maceroli M, Shields E, Sanders RW. Peroneal Tendon Instability in Intra-Articular Calcaneus Fractures: A Retrospective Comparative Study and a New Surgical Technique. *J Orthop Trauma.* 2016;30(3):e82-87.
21. Khoury NJ, el-Khoury GY, Saltzman CL, Brandser EA. Intraarticular foot and ankle injections to identify source of pain before arthrodesis. *AJR Am J Roentgenol.* 1996;167(3):669-673.
22. Lucas PE, Hurwitz SR, Kaplan PA, Dussault RG, Maurer EJ. Fluoroscopically guided injections into the foot and ankle: localization of the source of pain as a guide to treatment--prospective study. *Radiology.* 1997;204(2):411-415.
23. Henning PT. Ultrasound-Guided Foot and Ankle Procedures. *Phys Med Rehabil Clin N Am.* 2016;27(3):649-671.
24. Reach JS, Easley ME, Chuckpaiwong B, Nunley JA, 2nd. Accuracy of ultrasound guided injections in the foot and ankle. *Foot Ankle Int.* 2009;30(3):239-242.
25. Smith J, Maida E, Murthy NS, Kissin EY, Jacobson JA. Sonographically guided posterior subtalar joint injections via the sinus tarsi approach. *J Ultrasound Med.* 2015;34(1):83-93.
26. Bui-Mansfield LT, Kline M, Chew FS, Rogers LF, Lenchik L. Osteochondritis dissecans of the tibial plafond: imaging characteristics and a review of the literature. *AJR Am J Roentgenol.* 2000;175(5):1305-1308.
27. Bui-Mansfield LT, Lenchik L, Rogers LF, Chew FS, Boles CA, Kline M. Osteochondritis dissecans of the tarsal navicular bone: imaging findings in four patients. *J Comput Assist Tomogr.* 2000;24(5):744-747.
28. De Smet AA, Ilahi OA, Graf BK. Reassessment of the MR criteria for stability of osteochondritis dissecans in the knee and ankle. *Skeletal Radiol.* 1996;25(2):159-163.
29. Lee KB, Bai LB, Park JG, Yoon TR. A comparison of arthroscopic and MRI findings in staging of osteochondral lesions of the talus. *Knee Surg Sports Traumatol Arthrosc.* 2008;16(11):1047-1051.
30. Choi YS, Potter HG, Chun TJ. MR imaging of cartilage repair in the knee and ankle. *Radiographics.* 2008;28(4):1043-1059.
31. Griffith JF, Lau DT, Yeung DK, Wong MW. High-resolution MR imaging of talar osteochondral lesions with new classification. *Skeletal Radiol.* 2012;41(4):387-399.
32. Leumann A, Valderrabano V, Plaass C, et al. A novel imaging method for osteochondral lesions of the talus--comparison of SPECT-CT with MRI. *Am J Sports Med.* 2011;39(5):1095-1101.
33. Meftah M, Katchis SD, Scharf SC, Mintz DN, Klein DA, Weiner LS. SPECT/CT in the management of osteochondral lesions of the talus. *Foot Ankle Int.* 2011;32(3):233-238.
34. Tamam C, Tamam MO, Yildirim D, Mulazimoglu M. Diagnostic value of single-photon emission computed tomography combined with computed tomography in relation to MRI on osteochondral lesions of the talus. *Nucl Med Commun.* 2015;36(8):808-814.
35. Ng JM, Rosenberg ZS, Bencardino JT, Restrepo-Velez Z, Ciavarra GA, Adler RS. US and MR imaging of the extensor compartment of the ankle. *Radiographics.* 2013;33(7):2047-2064.

36. Waitches GM, Rockett M, Brage M, Sudakoff G. Ultrasonographic-surgical correlation of ankle tendon tears. *J Ultrasound Med.* 1998;17(4):249-256.
37. Nallamshetty L, Nazarian LN, Schweitzer ME, et al. Evaluation of posterior tibial pathology: comparison of sonography and MR imaging. *Skeletal Radiol.* 2005;34(7):375-380.
38. Grant TH, Kelikian AS, Jereb SE, McCarthy RJ. Ultrasound diagnosis of peroneal tendon tears. A surgical correlation. *J Bone Joint Surg Am.* 2005;87(8):1788-1794.
39. Astrom M, Gentz CF, Nilsson P, Rausing A, Sjoberg S, Westlin N. Imaging in chronic achilles tendinopathy: a comparison of ultrasonography, magnetic resonance imaging and surgical findings in 27 histologically verified cases. *Skeletal Radiol.* 1996;25(7):615-620.
40. Hartgerink P, Fessell DP, Jacobson JA, van Holsbeeck MT. Full- versus partial-thickness Achilles tendon tears: sonographic accuracy and characterization in 26 cases with surgical correlation. *Radiology.* 2001;220(2):406-412.
41. Guelfi M, Pantalone A, Vanni D, Abate M, Guelfi MG, Salini V. Long-term beneficial effects of platelet-rich plasma for non-insertional Achilles tendinopathy. *Foot Ankle Surg.* 2015;21(3):178-181.
42. Owens RF, Jr., Ginnetti J, Conti SF, Latona C. Clinical and magnetic resonance imaging outcomes following platelet rich plasma injection for chronic midsubstance Achilles tendinopathy. *Foot Ankle Int.* 2011;32(11):1032-1039.
43. Yeo A, Kendall N, Jayaraman S. Ultrasound-guided dry needling with percutaneous paratenon decompression for chronic Achilles tendinopathy. *Knee Surg Sports Traumatol Arthrosc.* 2016;24(7):2112-2118.
44. Neustadter J, Raikin SM, Nazarian LN. Dynamic sonographic evaluation of peroneal tendon subluxation. *AJR Am J Roentgenol.* 2004;183(4):985-988.
45. Roth JA, Taylor WC, Whalen J. Peroneal tendon subluxation: the other lateral ankle injury. *Br J Sports Med.* 2010;44(14):1047-1053.
46. Muir JJ, Curtiss HM, Hollman J, Smith J, Finnoff JT. The accuracy of ultrasound-guided and palpation-guided peroneal tendon sheath injections. *Am J Phys Med Rehabil.* 2011;90(7):564-571.
47. Wilkinson VH, Rowbotham EL, Grainger AJ. Imaging in Foot and Ankle Arthritis. *Semin Musculoskelet Radiol.* 2016;20(2):167-174.
48. Park HJ, Cha SD, Kim HS, et al. Reliability of MRI findings of peroneal tendinopathy in patients with lateral chronic ankle instability. *Clin Orthop Surg.* 2010;2(4):237-243.
49. Saxena A, Luhadiya A, Ewen B, Goumas C. Magnetic resonance imaging and incidental findings of lateral ankle pathologic features with asymptomatic ankles. *J Foot Ankle Surg.* 2011;50(4):413-415.
50. Giza E, Mak W, Wong SE, Roper G, Campanelli V, Hunter JC. A clinical and radiological study of peroneal tendon pathology. *Foot Ankle Spec.* 2013;6(6):417-421.
51. Jaffee NW, Gilula LA, Wissman RD, Johnson JE. Diagnostic and therapeutic ankle tenography: outcomes and complications. *AJR Am J Roentgenol.* 2001;176(2):365-371.
52. Park HJ, Cha SD, Kim SS, et al. Accuracy of MRI findings in chronic lateral ankle ligament injury: comparison with surgical findings. *Clin Radiol.* 2012;67(4):313-318.
53. Crim J, Longenecker LG. MRI and surgical findings in deltoid ligament tears. *AJR Am J Roentgenol.* 2015;204(1):W63-69.
54. Oae K, Takao M, Naito K, et al. Injury of the tibiofibular syndesmosis: value of MR imaging for diagnosis. *Radiology.* 2003;227(1):155-161.
55. Nielson JH, Sallis JG, Potter HG, Helfet DL, Lorich DG. Correlation of interosseous membrane tears to the level of the fibular fracture. *J Orthop Trauma.* 2004;18(2):68-74.
56. DiGiovanni BF, Fraga CJ, Cohen BE, Shereff MJ. Associated injuries found in chronic lateral ankle instability. *Foot Ankle Int.* 2000;21(10):809-815.
57. Chien AJ, Jacobson JA, Jamadar DA, Brigido MK, Femino JE, Hayes CW. Imaging appearances of lateral ankle ligament reconstruction. *Radiographics.* 2004;24(4):999-1008.
58. Guillodo Y, Varache S, Saraux A. Value of ultrasonography for detecting ligament damage in athletes with chronic ankle instability compared to computed arthrotomography. *Foot Ankle Spec.* 2010;3(6):331-334.
59. Lee KT, Park YU, Jegal H, Park JW, Choi JP, Kim JS. New method of diagnosis for chronic ankle instability: comparison of manual anterior drawer test, stress radiography and stress ultrasound. *Knee Surg Sports Traumatol Arthrosc.* 2014;22(7):1701-1707.
60. Christodoulou G, Korovessis P, Giarmenitis S, Dimopoulos P, Sdougos G. The use of sonography for evaluation of the integrity and healing process of the tibiofibular interosseous membrane in ankle fractures. *J Orthop Trauma.* 1995;9(2):98-106.

61. Lee BH, Choi KH, Seo DY, Choi SM, Kim GL. Diagnostic validity of alternative manual stress radiographic technique detecting subtalar instability with concomitant ankle instability. *Knee Surg Sports Traumatol Arthrosc.* 2016;24(4):1029-1039.
62. Bureau NJ, Cardinal E, Hobden R, Aubin B. Posterior ankle impingement syndrome: MR imaging findings in seven patients. *Radiology.* 2000;215(2):497-503.
63. Farooki S, Yao L, Seeger LL. Anterolateral impingement of the ankle: effectiveness of MR imaging. *Radiology.* 1998;207(2):357-360.
64. Fiorella D, Helms CA, Nunley JA, 2nd. The MR imaging features of the posterior intermalleolar ligament in patients with posterior impingement syndrome of the ankle. *Skeletal Radiol.* 1999;28(10):573-576.
65. Hauger O, Moinard M, Lasalarie JC, Chauveaux D, Diard F. Anterolateral compartment of the ankle in the lateral impingement syndrome: appearance on CT arthrography. *AJR Am J Roentgenol.* 1999;173(3):685-690.
66. Jordan LK, 3rd, Helms CA, Cooperman AE, Speer KP. Magnetic resonance imaging findings in anterolateral impingement of the ankle. *Skeletal Radiol.* 2000;29(1):34-39.
67. Peace KA, Hillier JC, Hulme A, Healy JC. MRI features of posterior ankle impingement syndrome in ballet dancers: a review of 25 cases. *Clin Radiol.* 2004;59(11):1025-1033.
68. Robinson P, White LM, Salonen D, Ogilvie-Harris D. Anteromedial impingement of the ankle: using MR arthrography to assess the anteromedial recess. *AJR Am J Roentgenol.* 2002;178(3):601-604.
69. Robinson P, White LM, Salonen DC, Daniels TR, Ogilvie-Harris D. Anterolateral ankle impingement: mr arthrographic assessment of the anterolateral recess. *Radiology.* 2001;221(1):186-190.
70. Rubin DA, Tishkoff NW, Britton CA, Conti SF, Towers JD. Anterolateral soft-tissue impingement in the ankle: diagnosis using MR imaging. *AJR Am J Roentgenol.* 1997;169(3):829-835.
71. Schaffler GJ, Tirman PF, Stoller DW, Genant HK, Ceballos C, Dillingham MF. Impingement syndrome of the ankle following supination external rotation trauma: MR imaging findings with arthroscopic correlation. *Eur Radiol.* 2003;13(6):1357-1362.
72. McCarthy CL, Wilson DJ, Coltman TP. Anterolateral ankle impingement: findings and diagnostic accuracy with ultrasound imaging. *Skeletal Radiol.* 2008;37(3):209-216.
73. Duncan D, Mologne T, Hildebrand H, Stanley M, Schreckengaust R, Sitler D. The usefulness of magnetic resonance imaging in the diagnosis of anterolateral impingement of the ankle. *J Foot Ankle Surg.* 2006;45(5):304-307.
74. Ferkel RD, Tyorkin M, Applegate GR, Heinen GT. MRI evaluation of anterolateral soft tissue impingement of the ankle. *Foot Ankle Int.* 2010;31(8):655-661.
75. Huh YM, Suh JS, Lee JW, Song HT. Synovitis and soft tissue impingement of the ankle: assessment with enhanced three-dimensional FSPGR MR imaging. *J Magn Reson Imaging.* 2004;19(1):108-116.
76. Donovan A, Rosenberg ZS. MRI of ankle and lateral hindfoot impingement syndromes. *AJR Am J Roentgenol.* 2010;195(3):595-604.
77. Cochet H, Pele E, Amoretti N, Brunot S, Lafenetre O, Hauger O. Anterolateral ankle impingement: diagnostic performance of MDCT arthrography and sonography. *AJR Am J Roentgenol.* 2010;194(6):1575-1580.
78. Messiou C, Robinson P, O'Connor PJ, Grainger A. Subacute posteromedial impingement of the ankle in athletes: MR imaging evaluation and ultrasound guided therapy. *Skeletal Radiol.* 2006;35(2):88-94.
79. Jones DM, Saltzman CL, El-Khoury G. The diagnosis of the os trigonum syndrome with a fluoroscopically controlled injection of local anesthetic. *Iowa Orthop J.* 1999;19:122-126.
80. Rodop O, Mahirogullari M, Akyuz M, Sonmez G, Turgut H, Kuskucu M. Missed talar neck fractures in ankle distortions. *Acta Orthop Traumatol Turc.* 2010;44(5):392-396.
81. Niva MH, Sormaala MJ, Kiuru MJ, Haataja R, Ahovuo JA, Pihlajamaki HK. Bone stress injuries of the ankle and foot: an 86-month magnetic resonance imaging-based study of physically active young adults. *Am J Sports Med.* 2007;35(4):643-649.
82. Sormaala MJ, Niva MH, Kiuru MJ, Mattila VM, Pihlajamaki HK. Stress injuries of the calcaneus detected with magnetic resonance imaging in military recruits. *J Bone Joint Surg Am.* 2006;88(10):2237-2242.
83. Khoury V, Cardinal E, Bureau NJ. Musculoskeletal sonography: a dynamic tool for usual and unusual disorders. *AJR Am J Roentgenol.* 2007;188(1):W63-73.
84. Raikin SM, Elias I, Nazarian LN. Intrasheath subluxation of the peroneal tendons. *J Bone Joint Surg Am.* 2008;90(5):992-999.
85. Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. *AJR Am J Roentgenol.* 2004;183(3):615-622.

86. Hirschmann MT, Davda K, Rasch H, Arnold MP, Friederich NF. Clinical value of combined single photon emission computerized tomography and conventional computer tomography (SPECT/CT) in sports medicine. *Sports Med Arthrosc.* 2011;19(2):174-181.
87. Chin KJ, Wong NW, Macfarlane AJ, Chan VW. Ultrasound-guided versus anatomic landmark-guided ankle blocks: a 6-year retrospective review. *Reg Anesth Pain Med.* 2011;36(6):611-618.
88. Redborg KE, Antonakakis JG, Beach ML, Chinn CD, Sites BD. Ultrasound improves the success rate of a tibial nerve block at the ankle. *Reg Anesth Pain Med.* 2009;34(3):256-260.
89. Redborg KE, Sites BD, Chinn CD, et al. Ultrasound improves the success rate of a sural nerve block at the ankle. *Reg Anesth Pain Med.* 2009;34(1):24-28.
90. American College of Radiology. ACR Appropriateness Criteria®: Chronic Foot Pain. Available at: https://acsearch.acr.org/docs/69424/Narrative/. Accessed December 4, 2017.
91. Bencardino JT, Stone TJ, Roberts CC, et al. ACR Appropriateness Criteria(R) Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae. *J Am Coll Radiol.* 2017;14(5S):S293-S306.
92. American College of Radiology. ACR Appropriateness Criteria®: Primary Bone Tumors. Available at: https://acsearch.acr.org/docs/69421/Narrative/. Accessed December 4, 2017.
93. American College of Radiology. ACR Appropriateness Criteria®: Metastatic Bone Disease. Available at: https://acsearch.acr.org/docs/69431/Narrative/. Accessed December 4, 2017.
94. American College of Radiology. ACR Appropriateness Criteria®: Soft-Tissue Masses. Available at: https://acsearch.acr.org/docs/69434/Narrative/. Accessed December 4, 2017.
95. Jacobson JA, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria(R) Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis. *J Am Coll Radiol.* 2017;14(5S):S81-S89.
96. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: http://www.acr.org/~/media/ACR/Documents/AppCriteria/RadiationDoseAssessmentIntro.pdf. Accessed December 4, 2017.