American College of Radiology
ACR Appropriateness Criteria®
Chronic Foot Pain

Variant: 1 Adult. Chronic foot pain. Unknown etiology. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography foot	Usually Appropriate	☢
US foot	Usually Not Appropriate	O
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	Usually Not Appropriate	Varies
MRI foot without and with IV contrast	Usually Not Appropriate	O
MRI foot without IV contrast	Usually Not Appropriate	O
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
CT foot without IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

Variant: 2 Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
US foot	Usually Appropriate	O
MRI foot without IV contrast	Usually Appropriate	O
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	May Be Appropriate	Varies
MRI foot without and with IV contrast	Usually Not Appropriate	O
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
CT foot without IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

Variant: 3 Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	O
CT foot without IV contrast	Usually Appropriate	☢
US foot	May Be Appropriate	O
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	May Be Appropriate	Varies
MRI foot without and with IV contrast	Usually Not Appropriate	O
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

Variant: 4 **Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	O
CT foot without IV contrast	Usually Appropriate	☢
US foot	May Be Appropriate	O
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	May Be Appropriate	Varies
MR arthrography foot	May Be Appropriate	O
MRI foot without and with IV contrast	Usually Not Appropriate	O
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

Variant: 5 **Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US foot	Usually Appropriate	O
MRI foot without and with IV contrast	May Be Appropriate	O
MRI foot without IV contrast	May Be Appropriate	O
CT foot with IV contrast	May Be Appropriate	☢
CT foot without IV contrast	May Be Appropriate	☢
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	Usually Not Appropriate	Varies
CT foot without and with IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

Variant: 6 **Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	O
US foot	May Be Appropriate	O
Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures	May Be Appropriate (Disagreement)	Varies
MRI foot without and with IV contrast	May Be Appropriate	O
3-phase bone scan foot	May Be Appropriate	☢☢☢
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
CT foot without IV contrast	Usually Not Appropriate	☢
Bone scan foot	Usually Not Appropriate	☢☢☢

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Summary of Literature Review

Introduction/Background

The foot is composed of 26 bones (not including sesamoids) with complex articular relationships functioning as a base for weightbearing and allowing for locomotion [1]. The foot can be divided into 3 anatomic divisions to include hindfoot (talus and calcaneus), midfoot (remaining tarsal bones), and forefoot (metatarsals and phalanges). Dynamic forces propagate through these divisions during the different phases of gait [1,2]. Alternatively, the foot can be divided into 2 to 3 longitudinal columns that extend from the hindfoot to the forefoot [2]. Lastly, the bones of the foot form longitudinal and transverse arches that define alignment and influence biomechanics. A general understanding of complex anatomic relationships can guide clinical assessment and correlation with imaging findings.

Chronic foot pain is a frequent clinical complaint, with approximately 14% to 42% of adults in the United States reporting foot problems, often with significant impact on mobility, difficulty performing daily activities, and increased risk of falling, particularly in older individuals [3,4]. Randomized controlled trials have demonstrated a significant improvement in health-related quality of life with effective treatment of foot pain [5]. Estimating the prevalence of chronic foot pain is challenging, because there is no consensus regarding the definition of chronic pain in the literature. The International Association for the Study of Pain defines chronic pain as any pain persisting past the normal healing time, suggesting 3 months in the case of chronic pain of benign causes.

Women are more commonly affected, and forefoot conditions are more frequent. Persistent pain for more than 6 years has been reported in 51% of women between 70 to 75 years of age [6]. Because of the wide range of causes of chronic foot pain, assessment of these patients with imaging studies in addition to a dedicated clinical examination is often needed [4].

Chronic foot pain in children, symptoms related to soft tissue or bone neoplasms and pain related to infectious conditions, inflammatory arthropathies, or other systemic diseases are beyond the scope of this document. Evaluation of patients with neuropathic foot or Charcot arthropathy is addressed in the ACR Appropriateness Criteria® topic on "Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus" [7]. Posttraumatic entities affecting the ankle, including instability, arthrosis, osteochondral defects, osteonecrosis, and tendinopathies, are discussed in ACR Appropriateness Criteria® topic on "Chronic Ankle Pain" [8]. Infectious and inflammatory arthropathies are discussed in ACR Appropriateness Criteria® topics on "Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot)" [9] and "Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis" [10]. Acute traumatic injuries of the foot including Lisfranc injuries are discussed in ACR Appropriateness Criteria® topic on "Acute Trauma to the Foot" [11].

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 (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

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

Discussion of Procedures by Variant

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.

When a patient presents with chronic foot pain, initial imaging should provide a general overview of the potential contributors to foot pain including alignment, osseous, joint space, and soft tissue abnormalities. Initial imaging should be used in correlation with clinical symptoms to guide treatment or future imaging decisions when necessary.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
A. Bone scan foot

There is insufficient evidence to support the use of bone scan foot in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
B. CT foot with IV contrast

There is insufficient evidence to support the use of CT foot with intravenous (IV) contrast in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
C. CT foot without and with IV contrast

There is insufficient evidence to support the use of CT foot without and with IV contrast in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
D. CT foot without IV contrast

There is insufficient evidence to support the use of CT foot without IV contrast in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
E. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

There is insufficient evidence to support the use of image-guided anesthetic without and with corticosteroid injection foot or surrounding structures in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
F. MRI foot without and with IV contrast

There is insufficient evidence to support the use of MRI foot without and with IV contrast in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
G. MRI foot without IV contrast

There is insufficient evidence to support the use of MRI foot without IV contrast in the initial evaluation of chronic foot pain.

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
H. Radiography foot

Conventional radiography can be useful to distinguish between different causes of chronic foot pain and is the most useful imaging study in evaluating patients with chronic foot pain. Specific changes in quantifiable skeletal parameters of the foot, such as the talonavicular angle, occur when comparing nonweightbearing and weightbearing foot radiographs. Weightbearing radiographs have demonstrated increased sensitivity for detecting alignment abnormalities contributing to flattening of the medial arch, increasing hindfoot valgus, and midfoot external rotation and abduction. Such alignment relationships include the talonavicular coverage angle, talocalcaneal angle, and cuboid height to ground distance [12,13]. When combined with clinical data, radiographs provide information about alignment and can narrow the anatomic division contributing to the patient's symptoms. In doing so, specific abnormalities can be inferred or suspected from radiographs to guide more advanced imaging when necessary.

The value of radiographs in the diagnosis of tarsal coalitions has been extensively demonstrated. Overall sensitivities ranging from 80% to 100% and specificities ranging from 97% to 98% have been reported for radiographs in the diagnosis of calcaneonavicular coalitions. Most calcaneonavicular coalitions are detected on lateral and oblique radiographs of the foot, confirmed on sagittal CT or MRI scans when necessary [14]. Talocalcaneal or subtalar coalition may be overlooked on standard foot radiographs due to overlapping structures; however, secondary signs on the lateral view could suggest a subtalar coalition. An overall sensitivity of 100% and a specificity of 88% have been found for radiographs in the diagnosis of subtalar coalitions [15]. CT and MRI remain the most reliable methods for diagnosing subtalar coalitions.

Radiographs are the most useful in the clinical setting of a suspected stress fracture. A systematic review by Wright et al [16] reported sensitivities ranging from 12% to 56% and specificities ranging from 88% to 96% for radiographs in the detection of lower extremity stress fractures.

Radiographs are useful to assess several causes of forefoot pain. Radiographs are performed to evaluate the first metatarsal sesamoids and may be useful to diagnose sesamoid malalignment or osteoarthritis (OA) or to distinguish between chronic multipartite versus fractured sesamoid. Differentiation between a bipartite versus a fractured sesamoid and diagnosis of other conditions affecting the sesamoids remains difficult to assess with radiographs [15]. Radiographs are insensitive to diagnose Morton neuroma but are useful to exclude other causes of webspace pain such as OA, Freiberg infraction, and stress fractures. Splaying of the metatarsals or soft tissue density may be demonstrated but are not diagnostic of Morton neuroma [17].

Though radiography is typically insensitive in the diagnosis of fasciitis, it would be useful as the initial imaging study in patients with a painful heel. Evidence supports the use of weightbearing radiographs in this instance [18]. The combination of thickened plantar fascia and fat pad

abnormalities on radiographs has a sensitivity of 85% and a specificity of 95% for plantar fasciitis [19].

Variant 1: Adult. Chronic foot pain. Unknown etiology. Initial imaging.
I. US foot

Ultrasound (US) is usually not useful as the first imaging study in the evaluation of chronic foot pain, but it may be performed initially when there is a high clinical suspicion of pathologic conditions of the Achilles tendon, plantar fascia, and other conditions such as tarsal tunnel syndrome, Morton neuroma, plantar plate tears, and intermetatarsal bursitis.

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.

Foot pain suspected to originate from tendon, ligament, fascia, muscle, or other soft tissue abnormities may contribute to or result from malalignment. Abnormalities in the soft tissues have a myriad of etiologies including chronic stresses, posttraumatic changes, occult injury, or overuse. The goal of imaging is to identify abnormal structures, characterize the specific abnormality, and grade severity when possible. When taking the clinical scenario into account, imaging should guide treatment decisions and assist in preoperative planning when necessary.

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan foot

There is insufficient evidence to support the use of bone scan foot in the evaluation of chronic foot pain when pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected.

Although a characteristic pattern of abnormal uptake on 3-phase bone scintigraphy has been proven helpful to differentiate plantar fasciitis from calcaneal stress or avulsion fractures [20], MRI and US remain the modalities of choice when heel pain related to the plantar fascia is suspected.

Single-photon emission computed tomography (SPECT)/CT has been found to be of use when investigating heel pain with increased specificity when compared with bone scintigraphy alone, because of the improved anatomic localization of metabolic activity. Despite the anatomic and functional advantages of SPECT/CT, MRI and US remain the more-frequently used imaging modalities in patients with heel pain [20].

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
B. CT foot with IV contrast

There is insufficient evidence to support the use of CT foot with IV contrast in the evaluation of chronic foot pain when pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected.

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
C. CT foot without and with IV contrast

There is insufficient evidence to support the use of CT foot without and with IV contrast in the evaluation of chronic foot pain when pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected.

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other

soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
D. CT foot without IV contrast

There is insufficient evidence to support the use of CT foot without IV contrast in the evaluation of chronic foot pain when pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected.

In a study comparing the diagnostic performance of CT arthrography and US for the diagnosis of anterolateral ankle impingement, Cochet et al [21] determined that CT arthrography is quite accurate, with a sensitivity of 97% and specificity of 71%.

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
E. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

Several articles have shown the usefulness of image-guided anesthetic tendon sheath injections to improve clinical confidence when tendon abnormalities are suspected [22]. Furthermore, image-guided injections can validate the source of pain when tenosynovitis is discovered on MRI or US. Confirming a specific tendon as a source of pain can be valuable in guiding patient treatment options, leading to better outcomes by providing guidance for staging severity of the disease and planning appropriate therapy including surgical decision making [22,23]. Including corticosteroids in the injectate has been shown to provide long-term complete or near-complete resolution of pain in 47% of patients [22,24].

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
F. MRI foot without and with IV contrast

There is insufficient evidence to support the use of MRI foot without and with IV contrast of the foot or surrounding structures in the evaluation of chronic foot pain when pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected.

The usefulness of MRI when chronic foot pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected is discussed below. The use of IV gadolinium contrast material is usually not indicated to detect abnormalities in this clinical scenario [25]. MRI foot without and with IV gadolinium contrast material may facilitate detection of Morton neuromas in specific clinical scenarios resulting from improved soft tissue contrast [26,27].

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
G. MRI foot without IV contrast

MRI is the most useful modality when chronic foot pain originating from tendon, ligament, fascia, muscle, or other soft tissue is suspected. MRI has good accuracy for demonstrating tendon, ligament, and fascial abnormalities while allowing comprehensive evaluation of other regional soft tissue and osseous structures [28]. Thus, MRI can readily demonstrate the constellation of abnormalities present in several chronic foot pain syndromes such as the progressive collapsing foot deformity, cuboid pulley lesions, impingement syndromes, and chronic instability [2,29,30].

In the setting of acquired flatfoot deformity, also referred to as progressive collapsing foot deformity, MRI is the preferred modality for assessment of the primary and secondary stabilizers of the foot. MRI readily demonstrates tendon abnormalities to include tendinosis, tenosynovitis, and

tendon tears. Similarly, MRI provides good delineation of associated ligament abnormalities including the sequela of chronic injury, degeneration, and associated regional preligamentous soft tissue abnormalities. Associated abnormities such as peroneal tendon abnormalities, subfibular impingement, and sinus tarsi impingement syndrome are well characterized by MRI [2,30]. Given that MRI is accepted as the modality of choice for assessing ligament and capsular structures, MRI may show ligament disruption or laxity in the setting of chronic joint instability [2].

Abnormalities associated with other chronic painful impingement syndromes can be identified by MRI including the changes contributing to, and resulting from, anterolateral, anteromedial, and posterior impingement. MR arthrography has been reported to have a sensitivity and specificity of 96% and 100%, respectively, for the diagnosis of anterolateral impingement. MRI provides the ability to assess characterize the cause of the impingement and effect on the regional structures [2].

MRI allows accurate characterization of the plantar fascia and adjacent soft tissues and bones, and several imaging findings have been described in patients with plantar fasciitis and partial or complete tears of the plantar fascia on MRI [31]. Given that, some of the findings in patients with plantar fasciitis are nonspecific; these findings can also be seen in asymptomatic patients, and therefore, MRI should always be correlated with clinical symptoms. Although no significant differences have been found in plantar fascia thickness on US and MRI, MRI is currently considered the most sensitive imaging study in the diagnosis of plantar fasciitis [32].

MRI is widely accepted as the imaging study of choice for diagnosis of plantar plate tears. In a prospective study, Sung et al [33] found high accuracy (96%), sensitivity (95%), specificity (100%), positive predictive value (PPV) (100%), and negative predictive value (NPV) (67%) for MRI with surgical correlation. In this study, moderate concordance was found between tear severity on MRI and surgery, with greater concordance at higher severity. A meta-analysis showed higher diagnostic accuracy for MRI than US for the detection of plantar plate tears, with a sensitivity and specificity for MRI of 95% and 54%, respectively [34]. MR arthrography improves visualization of pericapsular structures when compared with conventional MRI and therefore can be useful in the diagnosis and characterization of plantar plate tears and abnormalities of related structures [35,36].

The most commonly used imaging modalities in the diagnosis of Morton neuroma are MRI and US. It has been shown that MRI has a significant effect in the diagnostic and therapeutic decisions made by orthopedic surgeons thanks to an increase in their confidence levels contributing to change in treatment [37]. MRI is believed to be a sensitive and reliable method to evaluate patients with metatarsalgia and Morton neuroma. One study quotes a sensitivity of 87%, specificity of 100%, accuracy of 89%, PPV of 100%, and NPV of 60% in surgically treated patients [38]. A more recent comparison of clinical assessment, MRI, and US reports that MRI has a sensitivity of 94%, specificity of 50%, PPV of 99%, and NPV of 17% in patients who underwent excision by a foot and ankle specialty surgeon for a presumed interdigital neuroma [39]. In a meta-analysis, MRI had a pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 93%, 68%, 1.89, and 0.19, respectively [40]. Increased fluid within the intermetatarsal bursa, suggesting bursitis, is well demonstrated on MRI [41]. Although the use of IV gadolinium is not essential to detect Morton neuromas [25], it may facilitate its detection because of the improved soft tissue contrast [26,27].

Lastly, MRI is a useful modality when assessing for anatomic variants such as accessory muscles that can contribute to chronic foot pain in select clinical scenarios [2].

Variant 2: Adult. Chronic foot pain. Suspect tendon or ligament or fascia or muscle or other soft tissue origin. Radiographs negative or indeterminate. Next imaging study.
H. US foot

Although MRI is generally accepted as the preferred modality for assessing chronic foot pain suspected to originate from tendon, ligament, fascia, muscle, or other soft tissue, targeted US can be used to assess abnormalities in specific clinical scenarios [28]. Like MRI, US can show tendon abnormalities including tendinosis, tenosynovitis, and tendon tears. Furthermore, US allows for dynamic assessment of the targeted structures useful for evaluating patients suspected of having tendon instability, subluxation, or dislocation that may be related to retinacular disruptions [2,28]. US can also be used to assess specific ligament integrity and may provide information about periligamentous soft tissue abnormalities for which dynamic assessment can enhance diagnostic accuracy when correlating with clinical symptoms.

US is accurate in detecting the hallmarks of anterolateral impingement particularly when synovitic lesions are >1 cm in size and associated with clinical symptoms of anterolateral impingement [79]. Furthermore, US readily demonstrates associated ligament abnormalities and can be used to differentiate soft tissue from osseous impingement [42]. One study concluded that US is less sensitive and specific compared with MRI and CT arthrography for diagnosing anterolateral impingement with a sensitivity and specificity of 77% and 57%, respectively [21]. The same study suggested Doppler US has proven useful in identifying increased vascularity in the setting of ankle impingement [21].

US has shown good sensitivity (80%) and specificity (88%) in the diagnosis of plantar fasciitis when compared with MRI [43]. A diagnostic accuracy of 69% for abnormal focal echogenicity within the plantar fascia, 60% for edema around the plantar fascia, 78% for perifascial edema, 69% for rupture of the plantar fascia, and 56% for an associated calcaneal spur have been found for US, using MRI as the reference standard [44]. Kapoor et al [45] showed higher sensitivity and specificity of US elastography when compared with US in the detection of plantar fasciitis (95% and 100% versus 66% and 75%, respectively), using MRI as the reference standard. US has been shown to be useful in the diagnosis of complete and partial tears of the plantar fascia [46]. Some authors regard US to be superior to MRI in differentiating true fiber interruption and tearing of the plantar fascia from edema [47]. The ability to perform dynamic imaging is a clear advantage for US imaging such as in cases when patients report the sensation of “snapping” or “popping” in the heel, which raises suspicion for fat pad subluxation. In these specific clinical scenarios, dynamic US evaluation may be the best test [48].

US has been shown to be useful in diagnosing tears of the sesamoid phalangeal ligament in the setting of turf toe [49]. MRI is generally better, but US is also useful in the diagnosis of plantar plate tears. In a cadaveric study, an accuracy, sensitivity, and specificity of 79%, 78%, and 80%, respectively, were found for US [50]. With MRI as the reference standard, Gregg et al [51] showed a sensitivity, specificity, PPV, NPV, and accuracy of 91%, 44%, 93%, 35%, and 85%, respectively, for US in the detection of metatarsophalangeal plantar plate tears in symptomatic subjects. A meta-analysis showed higher diagnostic accuracy for MRI than US for the detection of plantar plate tears. In this meta-analysis the sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio were 93%, 33%, 1.2, and 0.35, respectively, for US [34].

Morton neuroma and fluid-filled intermetatarsal bursae can be demonstrated on US. High-resolution US can approach the sensitivity of MRI in detecting Morton neuromas and US has the advantage of allowing clinical correlation during examination. High sensitivities for US and MRI (83%-96% and 82%-96%, respectively) with no significant differences between the 2 modalities were found in a meta-analysis [40]. Other authors have found higher diagnostic capabilities of US over MRI in the diagnosis of Morton neuroma with pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 90%, 88%, 2.77, and 0.16 for US and 93%, 68%, 1.89, and 0.19 for MRI [52].

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.

Foot pain suspected to originate from occult fracture, painful ossicles, or pain of other osseous origin can be the result of remote trauma, chronic stress, or anatomic variants. The goal of imaging is to identify abnormal osseous structures and determine whether the abnormality correlates with the clinical scenario. When taking the clinical scenario into account, imaging should guide treatment decisions and assist in preoperative planning when necessary.

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan foot

Bone scintigraphy is a sensitive but not specific technique to detect occult fractures because of its capability to detect increased osteoblastic activity. Although bone scans may reveal focal uptake at the site of a radiographically occult fracture, given the anatomical complexity of the foot particularly the midfoot, precise localization may be limited [53]. SPECT/CT may improve the diagnosis of patients with suspected fractures because of the more precise anatomical localization [54].

Planar bone scintigraphy has low anatomic resolution and has been shown to be a nonspecific technique to assess the hallucal sesamoids [55]. However, bone scintigraphy with SPECT/CT increases contrast resolution and anatomic localization of foci with increased osteoblastic activity [56]. Bone scintigraphy may demonstrate increased uptake in pathologic conditions affecting the first metatarsal sesamoids not evident on radiographs. A less dramatic uptake is noted in stress fractures, which may be helpful to differentiate between them and acute fractures [57]. When an indeterminate linear lucency is visualized on radiographs, a negative bone scintigraphy suggests chronic multipartite sesamoid [15]. Other conditions that may present positive findings on Tc-99m-methylene diphosphonate (MDP) bone scintigraphy include sesamoiditis, inflammatory or crystal deposition arthropathies, OA, and osteonecrosis [27]. In Freiberg infraction, a photopenic center with a hyperactive collar may be identified in the early stages on high-resolution Tc-99m-MDP bone scintigraphy [58].

Symptomatic accessory navicular bones were initially studied with Tc-99m-MDP bone scans and were reported to show increased radiotracer uptake at the synchondrosis, apparently due to the chronic stress phenomenon [59]. A negative bone scan can exclude the presence of a symptomatic accessory ossicle, but positive findings lack specificity [60,61]. Isotope bone scans, when combined with CT, may be positive in cases of painful accessory ossicles but remain relatively insensitive for some soft tissue pathology [62].

Although not widely used, 18F-sodium fluoride PET/CT has shown the ability to identify symptomatic accessory ossicles and may be increasingly used in the future in specific clinical scenarios, such as when patients report multiple pain locations, corresponding to known accessory ossicle locations [63].

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
B. CT foot with IV contrast

There is insufficient evidence to support the use of CT foot with IV contrast in the evaluation of chronic foot pain when occult fracture, painful ossicles, or pain of other osseous origin is suspected.

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
C. CT foot without and with IV contrast

There is insufficient evidence to support the use of CT foot without and with IV contrast in the evaluation of chronic foot pain when occult fracture, painful ossicles, or pain of other osseous origin is suspected.

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
D. CT foot without IV contrast

CT is useful for the detection of radiographically occult fractures. Almeida et al [64] reported visualization of Chopart fractures on CT and/or MRI in one-third of cases initially not diagnosed on radiographs. CT also has usefulness in the diagnosis of occult fractures involving the subtalar joint as demonstrated in the study by Choi et al [65]. CT is a primary imaging technique in patients with high-energy polytrauma and complex fractures, because radiographs have only poor to moderate sensitivity in this clinical setting [66]. More recently, dual-energy CT has been reported as a useful technique in the detection of bone marrow edema, with excellent performance in the appendicular skeleton, with a sensitivity of 98% and specificity of 93% [67]. This could potentially aid in the detection of radiographically occult fractures.

CT may be useful to confirm suspected sesamoid stress fractures on radiographs and to distinguish between a stress fracture and a bipartite sesamoid with more precision than conventional radiography [68]. CT is also useful to evaluate nonunion of sesamoid fractures in symptomatic patients with persistent bone marrow edema on MRI. Abnormalities in sesamoid position, which may be present in turf toe, hallux valgus, or OA, can also be assessed with CT [69]. CT is considered a useful and reliable method to determine the extent of necrosis in Freiberg infraction, which represents the main determining factor in the outcome [70]. There is no evidence in the literature supporting the routine use of contrast-enhanced CT imaging in the diagnosis of any of the conditions discussed above. Given the use of conventional arthrography in the detection of plantar plate tears, CT arthrography could presumably be of use in this setting [71].

CT may be useful to confirm the presence of an accessory ossicle, fragmentation or fracture, osteonecrosis, intraarticular bodies, or osteochondral abnormalities [60]. In contrast to conventional radiographs, CT offers multiplanar capability allowing detailed characterization of the ossicle and the synchondrosis. Assessment of associated soft tissue pathology or bone marrow edema on CT is limited when compared with MRI [72].

Whereas CT arthrography is not routinely performed when assessing for occult fracture, painful ossicles, or pain of other osseous, it has been suggested that CT arthrography may demonstrate disruption of the synchondrosis in the setting of suspected so trigonum syndrome [73].

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
E. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

If a painful accessory ossicle is suspected and imaging reveals a sesamoid or accessory ossicle corresponding to the patient's site of pain, targeted therapeutic injections can be used both to increase diagnostic confidence and to provide symptomatic relief. Monitoring pain response to anesthetic-only injections can confirm the ossicles as the pain generator [60]. Importantly, injection related risks must be considered based on the target location before proceeding with image-guided injections for pain suspected to arise from an ossicle.

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
F. MRI foot without and with IV contrast

There is insufficient evidence to support the use of MRI foot without and with IV contrast in the evaluation of chronic foot pain when occult fracture, painful ossicles, or pain of other osseous origin is suspected.

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
G. MRI foot without IV contrast

MRI allows the visualization of bone marrow edema patterns, which improves the detection of fractures in cases of negative or inconclusive radiographs [74]. The usefulness of MRI in the detection of radiographically occult Chopart fractures has been demonstrated by Almeida et al [64]. Baker et al [75] analyzed 31 occult fractures involving the ankle and foot in hockey players, finding 5 occult fractures in the foot, all of which involved the navicular bone. Pierre-Jerome et al [76] found 79% of cuboid fractures in the diabetic population that were radiographically occult using MRI. MRI is also useful in the detection of occult fractures involving the fifth metatarsal bone (Jones fracture) and the subtalar joint [65,77].

MRI is useful in the diagnosis of several conditions affecting the hallux sesamoid bones, including fractures, acute and chronic stress related changes, and avascular necrosis, for which a variety of MRI findings have been described in the literature [15]. MRI without and with IV contrast material administration is not routinely performed in the assessment of noninfectious/nontumoral conditions affecting the hallux sesamoids; however, it could be useful to distinguish between sesamoiditis and avascular necrosis [26,78].

MRI has replaced bone scans in the evaluation of painful ossicles and symptomatic accessory ossicles. MRI allows optimal visualization of the bone marrow within the ossicle and visualization of the synchondrosis. Accessory ossicles may also be associated with tendon pathology and surrounding soft tissue abnormalities, which are also well assessed on MRI [60,79,80]. For example, MRI allows clear demonstration of the soft tissue findings often associated with posterior ankle impingement syndrome [81].

MRI may be helpful to diagnose Freiberg infraction, and several nonspecific findings have been described in early and chronic stages [26,82]. There is no evidence in the literature supporting the routine use of IV contrast material in the setting of avascular necrosis [83].

Although MR arthrography is not routinely performed when assessing for occult fracture, painful ossicles, or pain of other osseous origin, it has been shown to reveal a disrupted synchondrosis in some studies [73].

Variant 3: Adult. Chronic foot pain. Suspect occult fracture or painful ossicles or pain of other osseous origin. Radiographs negative or indeterminate. Next imaging study.
H. US foot

Although not routinely performed, previous studies have demonstrated the role of US in the detection of occult foot fractures. On US, these can be seen as cortical irregularities and are frequently associated with soft tissue injury in the acute or subacute setting. Wang et al [84] demonstrated 24 cases of radiographically occult ankle and foot fractures in 268 patients. Of these, foot fractures were found most frequently in the calcaneus and metatarsals and less frequently in the navicular, cuboid, and cuneiform bones.

On US, several findings have been reported in cases of painful accessory ossicles, including patients with posterior ankle impingement syndrome; however, optimal characterization of the synchondrosis is difficult on US [61]. High-resolution US offers some advantages over other imaging modalities because it allows for dynamic exploration of the foot with further assessment of stability of the synchondrosis and tendon tears when present. US also allows for direct clinical correlation and comparative evaluation with the asymptomatic foot [85].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.

Foot pains suspected to arise from an osteochondral lesion, cartilage abnormality, degenerative joint disease, or pain from other articular origin can be a diagnostic dilemma. This is largely secondary to the complexity of the foot articular relationships. Midfoot OA is a significant clinical conundrum and particularly difficult to diagnose on imaging. The goal of imaging is to identify the abnormal joints that are most likely contributing to pain and characterize the abnormality based on involvement of the hyaline cartilage and/or subchondral bone plate. When taking the clinical scenario into account, imaging should guide treatment decisions and assist in preoperative planning when necessary.

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan foot

There is insufficient evidence to support the use of bone scan foot in the evaluation of chronic foot pain when osteochondral lesion, cartilage abnormality, degenerative joint disease, or pain of other articular origin is suspected.

Bone scintigraphy is sensitive in detecting areas of increased bone turnover, making it useful for identifying more symptomatic areas of OA from quiescent areas. However, bone scintigraphy is not specific for any pathology, and the diagnosis of symptomatic OA should occur in context with

other imaging.

SPECT/CT has been shown to influence diagnosis and treatment plans in patients with suspected symptomatic degenerative joint disease [86]. Specifically, SPECT/CT was found to have the most diagnostic value in patients with tarsometatarsal joint OA [86].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
B. CT foot with IV contrast

There is insufficient evidence to support the use of CT foot with IV contrast in the evaluation of chronic foot pain when osteochondral lesion, cartilage abnormality, degenerative joint disease, or pain of other articular origin is suspected.

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
C. CT foot without and with IV contrast

There is insufficient evidence to support the use of CT foot without and with IV contrast in the initial evaluation of chronic foot pain when osteochondral lesion, cartilage abnormality, degenerative joint disease, or pain of other articular origin is suspected.

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
D. CT foot without IV contrast

CT is an excellent modality to detect articular surface fractures, subchondral bone plate irregularities, joint space narrowing, and other signs of osteochondral damage [87]. Recently, the advent of weightbearing cone-beam CT (WBCT) has allowed weightbearing cross-sectional assessment of the foot to better characterize osteoarticular relationships. Steadman et al [88] found that WBCT had substantially better sensitivity, specificity, and characterization of midfoot joints when compared with radiographs. WBCT can provide exact and detailed evaluation of foot pathologies including information about alignment and degenerative joint disease while the patient is in a natural standing position [89]. Unlike conventional radiography, WBCT can also produce radiograph-like planar images without parallax and may produce more accurate and reproducible depictions of osseous alignment [87]. The soft tissue contrast of WBCT is relatively poor, making it difficult to detect associated periarticular abnormalities such as soft tissue swelling, effusions, fluid collections, and muscle atrophy [87]. When an osteochondral lesion is suspected, Deng et al [90] found that CT was reliable for characterizing and measuring osteochondral lesions of the talus.

Despite being sparsely used in musculoskeletal imaging, digital tomosynthesis has been found to provide more reliable weightbearing quantitative foot alignment values compared with radiography and more reliable osteoarthritic bony details compared with CT [91].

CT arthrography can be used to better characterize the stability of an in situ osteochondral fragment, better visualize surface chondral lesions, confirm intraarticular bodies that are outlined by contrast, and evaluate synovial proliferation in patients with impingement syndromes.

Arthrography can also assess the distensibility of the joint capsule, which may be decreased in patients with arthrofibrosis or increased in patients with capsular/ligamentous tears and insufficiency [87].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
E. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

Fluoroscopic, CT- and US-guided anesthetic intraarticular injections can be used for diagnostic purposes to identify a specific joint or group of joints that are contributing to chronic foot pain [92-94]. Narrowing the source of pain in the foot and ankle joints improves clinical confidence and can be valuable in guiding patient treatment options leading to better outcomes [24,93,95]. When corticosteroids are added to the injectate, intraarticular injections can provide short-term pain relief. One study demonstrated that patients with pain in the region of the Lisfranc joint and those with OA respond best to anesthetic and corticosteroid intraarticular injections with 74% and 62% of patients reporting greater than 50% pain relief, respectively [93].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
F. MR arthrography foot

MR arthrography can be used to better characterize the stability of an in situ osteochondral fragment, better visualize surface chondral lesions, confirm intraarticular bodies that are outlined by contrast, and evaluate synovial proliferation in patients with impingement syndromes. Arthrography can also assess the distensibility of the joint capsule, which may be decreased in patients with arthrofibrosis or increased in patients with capsular/ligamentous tears and insufficiency [87].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
G. MRI foot without and with IV contrast

There is insufficient evidence to support the use of MRI foot without and with IV contrast in the evaluation of chronic foot pain when osteochondral lesion, cartilage abnormality, degenerative joint disease, or pain of other articular origin is suspected.

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
H. MRI foot without IV contrast

In addition to assessing soft tissue pathology, MRI can diagnose and determine the degree of hindfoot, midfoot, and forefoot OA, including the presence of osteophytes, intraarticular bodies, and synovitis, which can be associated with impingement syndromes. Furthermore, MRI can identify subchondral bone marrow lesions deep to areas of hyaline cartilage loss, which can represent independent pain generators [87]. Hardware and imaging protocols tailored to the anatomy of interest allow for improved assessment of hyaline cartilage enabling visualization of the articulating chondral surfaces and detection of surface chondral loss and heterogeneity, which can indicate degeneration or articular cartilage injury [87]. As a result, MRI has become better at

characterizing cartilage defects and osteochondral lesions, which serve as precursors to OA [87]. Newer cartilage mapping techniques are largely investigational but can be used in special clinical scenarios to detect areas of early cartilage damage [87].

Variant 4: Adult. Chronic foot pain. Suspect osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin. Radiographs negative or indeterminate. Next imaging study.
I. US foot

Despite being less helpful to directly characterize intraarticular abnormalities, such as chondral loss and subchondral bone pathology, US can identify synovial proliferation and active synovitis on Doppler imaging, which can be present in OA or inflammatory arthropathies [87,96]. Inflammatory arthropathies are discussed in the ACR Appropriateness Criteria® topic on "Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis" [10]. In OA, areas of synovial hyperemia on Doppler imaging are often more symptomatic. Additionally, US can be used to detect juxtaarticular erosions and communicate cyst-like changes. The degree and distribution of synovitis along with the presence of juxtaarticular erosions can help distinguish OA from inflammatory arthropathies [87]. Some have reported that US is more sensitive than radiography in detecting early signs of OA, including the development of marginal osteophytes in some of the small joints in the hindfoot and midfoot [87,96,97]. In fact, Camerer et al [96] found that US of the midfoot is more sensitive than conventional radiography in the detection of osteophytes in patients suffering from noninflammatory joint disease. Meanwhile, alternate sources have found US and radiographs to have similar sensitivities for visualizing changes associated with OA [98]. Although US is not as sensitive as MRI in detecting erosions and subchondral cyst-like changes, it is probably similar to MRI in its ability to detect and characterize the degree of synovitis [87].

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.

When pain from a retained foreign body is suspected, the goal of imaging is to identify the location of the foreign object and relationship to adjacent structures, attempt to determine material composition, and assess changes in the surrounding soft tissues. When taking the clinical scenario into account, imaging should guide treatment decisions and assist in preoperative planning when necessary.

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan foot

There is insufficient evidence to support the use of bone scan foot in the evaluation of chronic foot pain when a foreign body is suspected.

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
B. CT foot with IV contrast

CT can evaluate for the complications of foreign body-associated soft tissues changes such as muscle/fascial edema, abscesses, sinus tracts, and vascular or tendon injuries, some of which are best evaluated with the administration of IV contrast material. However, some soft tissue changes associated with foreign bodies, such as peripheral edema, hyperemia, and inflammation are difficult to visualize and may require a more sensitive modality for assessing soft tissues, such as

MRI or US [99]

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
C. CT foot without and with IV contrast

CT can evaluate for the complications of foreign body-associated soft tissues changes such as muscle/fascial edema, abscesses, sinus tracts, and vascular or tendon injuries, some of which are best evaluated with the administration of IV contrast material [99]. However, there is insufficient evidence to support the use of CT foot without and with IV contrast in the evaluation of chronic foot pain when a foreign body is suspected.

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
D. CT foot without IV contrast

CT enables identification and precise localization of radiopaque foreign bodies of the musculoskeletal system and has been reported as 5 to 15 times more sensitive than radiography [100,101]. Furthermore, CT has been cited as the best imaging modality for identifying specific foreign materials [100]. Nonradiopaque foreign bodies can be hyperattenuating on CT and can therefore be detected with the appropriate window setting [99,101]. The ability for CT to detect foreign bodies depends on size and material composition of the suspected retained object. Materials with higher density values have smaller size thresholds for detection [102,103]. Carneiro et al [104] suggested using thin (1 mm) slice thickness to avoid missing small, retained objects.

When a chronic foreign body is suspected, CT may demonstrate associated adjacent osseous changes such as osteolysis, sclerosis, periosteal reaction, or intraosseous abscess [99,101,104]. CT can evaluate for the complications of foreign body-associated soft tissues changes such as muscle/fascial edema, abscesses, sinus tracts, and vascular or tendon injuries, some of which are best evaluated with the administration of IV contrast material. However, some soft tissue changes associated with foreign bodies, such as peripheral edema, hyperemia, and inflammation are difficult to visualize and may require a more sensitive modality for assessing soft tissues, such as MRI or US [99]. Although CT can readily identify foreign bodies embedded in bone, CT is not as sensitive as MRI for detecting surrounding bone marrow edema.

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
E. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

There is insufficient evidence to support the use of image-guided anesthetic without and with corticosteroid injection foot or surrounding structures in the evaluation of chronic foot pain when a foreign body is suspected.

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
F. MRI foot without and with IV contrast

In the absence of specific MRI morphologic and signal characteristics, chronic foreign body granulomas may mimic a soft tissue neoplasm with or without central necrosis [102]. Although contrast-enhanced MRI helps to characterize mass lesions, it does not always enable differentiation between foreign body-associated masses and tumor-like lesions. In case of infection, draining sinuses with markedly enhancing walls can be demonstrated on contrast-enhanced T1-weighted

fat-suppressed images [101].

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
G. MRI foot without IV contrast

MRI may be useful when a foreign body is suspected in certain complicated circumstances, such as when the clinical presentation is misleading. For example, the patient may not recall a penetrating injury and may present with a soft tissue mass, draining sinus from chronic infection, or other signs resulting from soft tissue, neurogenic, or vascular injuries, such as a pulsatile mass from a pseudoaneurysm [105,106].

Typically, foreign bodies are hypointense on both T1- and T2-weighted imaging [99,105]. Susceptibility artifact from metal provides information regarding foreign body material composition. The MRI appearance of the surrounding soft tissues is variable. Long-standing foreign bodies have surrounding granulation tissue, which often demonstrates evolution and structural alterations. For example, cystic appearing lesions and soft tissue abnormalities associated with a foreign body can mimic seroma, liquefied hematoma, or chronic abscess. In the absence of specific MRI morphologic and signal characteristics, chronic foreign body granulomas may mimic a soft tissue neoplasm with or without central necrosis [107]. A surrounding rim of intermediate intensity or hypointensity on both T1- and T2-weighted imaging may be present, suggesting a peripheral fibrotic capsule [107]. Although contrast-enhanced MRI helps to characterize mass lesions, it does not always enable differentiation between foreign body-associated masses and tumorous lesions. In case of infection, draining sinuses with markedly enhancing walls can be displayed on contrast-enhanced T1-weighted fat-suppressed images [101].

Care must be taken when performing an MRI when a foreign body is suspected. Although ferromagnetic retained objects are susceptible to movement when placed in a strong magnetic field, the risk is considered minimal in the chronic setting when fibrous encapsulation is presumed. When imaging metallic foreign bodies, there is a risk of heat deposition that may affect the surrounding soft tissues. The seriousness of the risk to the patient depends on the location of the object being imaged, specifically the relationship with adjacent critical anatomic structures. Thus, proper screening for metallic foreign bodies of the musculoskeletal system is recommended before performing MRI [108].

Variant 5: Adult. Chronic foot pain. Suspect foreign body. Radiographs negative or indeterminate. Next imaging study.
H. US foot

US has a high sensitivity and specificity for detecting foreign bodies that are not visible radiographically [99,109-111]. High-frequency (7.5-MHz or greater) linear transducers are optimal for evaluating suspected foreign bodies in the musculoskeletal system [109]. US provides accurate anatomic localization of foreign bodies in addition to information about composition and morphology [99,109]. Whereas most foreign bodies of the musculoskeletal system are hyperechoic, the sonographic appearance of a foreign body is related to the composition of the object itself [109,110]. Furthermore, artifacts deep to the foreign body being imaged provides information about the object's surface, which can help narrow the retained object's material composition [110,112,113]. Finally, US has the advantage of providing information regarding the soft tissues around the identified foreign body. In the chronic setting, fibrinous exudate, granulation tissue, and collagenous capsule formation may be detected [114]. US can demonstrate

complications resulting from the foreign body, including associated chronic tendon or muscle injuries and/or the sequela of chronic infection. Additionally, Doppler imaging provides an assessment of surrounding soft tissue vascularity and the relationship of the foreign body with the surrounding vascular structures [114].

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.

When foot pain is suspected to have neurogenic etiology, the goal of imaging is to determine the affected structures and associated nerve distribution. Additionally, when possible, imaging can provide the specific cause for the neurogenic changes, such as a space occupying lesion resulting in mass effect on a peripheral nerve. Imaging can also distinguish between acute and chronic denervation changes. When taking the clinical scenario into account, imaging should guide treatment decisions and assist in preoperative planning when necessary.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
A. 3-phase bone scan foot

A 3-phase bone scan may be useful in cases of suspected complex regional pain syndrome (CRPS) type I for which several imaging findings have been described. There is some variation in the literature regarding the diagnostic capabilities of 3-phase bone scan in the diagnosis of CRPS type I. Some authors have found 3-phase bone scan to have higher sensitivity (100%) and NPV (100%) when compared with MRI and conventional radiography, supporting use to rule-out disease [16]. A meta-analysis by Cappello et al [115] demonstrated a pooled sensitivity, specificity, NPV, and PPV of 78%, 88%, 88%, and 84%, respectively. There is no relevant literature to support the routine clinical use of nuclear medicine studies in the evaluation of CRPS type II or nerve entrapment neuropathies.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
B. Bone scan foot

There is insufficient evidence to support the use of CT foot with IV contrast in the initial evaluation of chronic foot pain when Baxter neuropathy, CRPS, entrapment syndrome, or other neurogenic origin is suspected.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
C. CT foot with IV contrast

There is insufficient evidence to support the use of CT foot with IV contrast in the initial evaluation of chronic foot pain when Baxter neuropathy, CRPS, entrapment syndrome, or other neurogenic origin is suspected.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
D. CT foot without and with IV contrast

There is insufficient evidence to support the use of CT foot without and with IV contrast in the initial evaluation of chronic foot pain when Baxter neuropathy, CRPS, entrapment syndrome, or other neurogenic origin is suspected.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
E. CT foot without IV contrast

There is insufficient evidence to support the use of CT foot without IV contrast in the initial evaluation of chronic foot pain when Baxter neuropathy, CRPS, entrapment syndrome, or other neurogenic origin is suspected.

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
F. Image-guided anesthetic +/- corticosteroid injection foot or surrounding structures

US-guided anesthetic peripheral nerve injections can be used for diagnostic purposes to identify a specific neuropathy contributing to chronic foot pain [116,117]. Identifying the peripheral nerve contributing to chronic foot pain improves clinical confidence and can be valuable in establishing the underlying cause for neurogenic pain, such as nerve entrapment [117]. When corticosteroids are added to the injectate, perineural injections can provide short-term pain relief [117].

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
G. MRI foot without and with IV contrast

MRI foot without and with IV contrast is the most useful modality in specific clinical scenarios such as when CRPS type I is suspected. CRPS is subdivided into type I and type II. CRPS type I encompasses reflex sympathetic dystrophy and similar conditions without a nerve injury, whereas CRPS type II occurs after a nerve injury [118]. Several findings have been described on MRI in patients with early and advanced CRPS type I reflex sympathetic dystrophy [119,120]. In general, MRI has been found to be a specific but nonsensitive modality for diagnosing CRPS type I. In a study by Schürmann et al [119], contrast-enhanced MRI was found to have a sensitivity of 13% to 43% and a specificity of 78% to 98%, resulting in low PPV and moderate NPV, suggesting that MRI cannot be used as a screening test. In contrast, Schweitzer et al [120] demonstrated higher sensitivity (87%) and PPV (100%) for contrast-enhanced MRI. A meta-analysis by Cappello et al [115] reported a pooled specificity, sensitivity, NPV, and PPV for MRI in the diagnosis of CRPS type I of 91%, 35%, 51%, and 64%, respectively. A more recent study by Agten et al [121] found no specific imaging features to correlate with CRPS. The same study found that bone marrow edema was absent in up to 50% of patients with CRPS.

Although there is paucity in the literature regarding MRI in the diagnosis of CRPS type II, given its capability to directly visualize and characterize the nerves and to detect signs of muscle denervation, MRI without and with IV contrast may be useful in cases of CRPS type II [122].

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.
H. MRI foot without IV contrast

MRI foot without IV contrast is typically the most useful modality when chronic foot pain stemming from neurogenic causes is suspected. In the chronic setting, muscle denervation results in atrophy and fatty infiltration [123]. Conversely, in the subacute and acute settings, intrinsic muscular signal changes include edema and contrast enhancement while atrophy and fatty infiltration are not expected [123]. Administration of IV contrast material is therefore not usually helpful in most clinical scenarios, when chronic pain from neurogenic etiology is suspected.

Compression of the inferior calcaneal nerve or Baxter neuropathy manifests as denervation changes of the abductor digiti minimi muscle. Because of its ability to demonstrate signal intensity changes in the presence of muscle denervation, MRI has been shown to be useful in the diagnosis of patients with Baxter neuropathy and in the exclusion of other causes of foot pain [124]. However, fatty atrophy of the abductor digiti minimi muscle is not a specific sign of Baxter neuropathy and can be found in 4% of asymptomatic patients [125].

Variant 6: Adult. Chronic foot pain. Suspect Baxter neuropathy or complex regional pain syndrome or entrapment syndrome or other neurogenic origin. Radiographs negative or indeterminate. Next imaging study.

I. US foot

US imaging allows detailed evaluation of the course and morphology of peripheral nerves in the foot and allows for an assessment of the surrounding soft tissues and marginal osseous structures that may contribute to nerve impingement. It has been suggested that certain peripheral nerve lesions are more easily seen with US compared with MRI [2]. Furthermore, the ability to perform a dynamic assessment can increase the sensitivity of the examination when correlated with the patient's clinical symptoms. In the setting of a normal US when nerve entrapment is suspected, US is useful in guiding percutaneous diagnostic local anesthetic or therapeutic steroid injections [126].

Compression of the inferior calcaneal nerve or Baxter neuropathy due to calcaneal enthesophytes, plantar fasciitis, or varices can result in heel pain. This nerve is best seen anterior to the calcaneus on MRI and US [124]. Presley et al [127] studied the visualization of the inferior calcaneal nerve on high-resolution US in a cadaveric foot, suggesting a possible role of high-resolution US in diagnostic and therapeutic injections around the inferior calcaneal nerve.

A few studies addressing the role of US in the diagnosis of CRPS type I reflex sympathetic dystrophy have been published. There is evidence showing that patients who have CRPS type I affecting the lower extremity have increased power Doppler flow compared with asymptomatic control patients, with a sensitivity of 73% and specificity of 92% [128]. Although there is no relevant literature to support the routine clinical use of US in the diagnosis of CRPS type II, high-resolution US may have a role giving its increasing use in nerve assessment [124].

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

Variant 1: Radiography of the foot is the most appropriate modality for the initial imaging of chronic foot pain of unknown etiology.
Variant 2: Either MRI foot without IV contrast or US foot is the most appropriate and equivalent alternative imaging studies when chronic foot pain is suspected to arise from tendon, ligament,

fascia, muscle, or other soft tissue origin and radiographs are negative or indeterminate. Image-guided anesthetic without and with corticosteroid injection of the foot or surrounding structures may be appropriate in certain clinical scenarios.

Variant 3: Either MRI foot without IV contrast or CT foot without IV contrast is the most appropriate and equivalent alternative imaging studies when chronic foot pain is suspected to arise from occult fracture, painful ossicles, or pain of other osseous origin and radiographs are negative or indeterminate. Image-guided anesthetic without and with corticosteroid injection of the foot or surrounding structures or US of the foot may be appropriate in certain clinical scenarios.

Variant 4: Either MRI foot without IV contrast or CT foot without IV contrast is the most appropriate and equivalent alternative imaging studies when chronic foot pain is suspected to arise from osteochondral lesion or cartilage abnormality or degenerative joint disease or pain of other articular origin and radiographs are negative or indeterminate. Image-guided anesthetic without and with corticosteroid injection foot or surrounding structures, MR arthrography foot, or US foot may be appropriate in certain clinical scenarios.

Variant 5: US foot is the most appropriate imaging study when chronic foot pain is suspected to arise from foreign body and radiographs are negative or indeterminate. MRI foot without IV contrast, MRI foot without and with IV contrast, CT foot without IV contrast, or CT foot with IV contrast may be appropriate in certain clinical scenarios.

Variant 6: MRI foot without IV contrast is the most appropriate imaging study when chronic foot pain is suspected to arise from Baxter neuropathy, CRPS, entrapment syndrome, or other neurogenic origin and radiographs are negative or indeterminate. MRI foot without and with IV contrast, 3-phase bone scan foot, US foot, or Image-guided anesthetic without and with corticosteroid injection foot or surrounding structures may be appropriate in certain clinical scenarios.

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.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

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."

References

1. McGlamry ED, Southerland JT, Vickers D, Boberg JS. McGlamry's comprehensive textbook of foot and ankle surgery. Fourth edition ed. Philadelphia: Wolters Kluwer

Health/Lippincott Williams & Wilkins; 2013.

2. Crim J. The painful lateral column of the foot: from back to front. [Review]. Skeletal Radiology. 51(6):1115-1125, 2022 Jun.

3. Hawke F, Burns J. Understanding the nature and mechanism of foot pain. Journal of Foot & Ankle Research. 2:1, 2009 Jan 14.J. foot ankle res.. 2:1, 2009 Jan 14.

4. Joong MA, El-Khoury GY. Radiologic evaluation of chronic foot pain. [Review] [32 refs]. Am Fam Physician. 76(7):975-83, 2007 Oct 01.

5. Hawke F, Burns J, Radford JA, du Toit V. Custom-made foot orthoses for the treatment of foot pain. [Review] [80 refs]. Cochrane Database of Systematic Reviews. (3)CD006801, 2008 Jul 16.Cochrane Database Syst Rev. (3)CD006801, 2008 Jul 16.

6. Menz HB.. Chronic foot pain in older people. [Review]. Maturitas. 91:110-4, 2016 Sep.Maturitas. 91:110-4, 2016 Sep.

7. Walker EA, Beaman FD, Wessell DE, et al. ACR Appropriateness Criteria® Suspected Osteomyelitis of the Foot in Patients With Diabetes Mellitus. J Am Coll Radiol 2019;16:S440-S50.

8. Chang EY, Tadros AS, Amini B, et al. ACR Appropriateness Criteria® Chronic Ankle Pain. J Am Coll Radiol 2018;15:S26-S38.

9. Pierce JL, Perry MT, Wessell DE, et al. ACR Appropriateness Criteria® Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot): 2022 Update. J Am Coll Radiol 2022;19:S473-S87.

10. Subhas N, Wu F, Fox MG, et al. ACR Appropriateness Criteria® Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis: 2022 Update. J Am Coll Radiol 2023;20:S20-S32.

11. Gorbachova T, Chang EY, Ha AS, et al. ACR Appropriateness Criteria® Acute Trauma to the Foot. J Am Coll Radiol 2020;17:S2-S11.

12. Shereff MJ, DiGiovanni L, Bejjani FJ, Hersh A, Kummer FJ. A comparison of nonweight-bearing and weight-bearing radiographs of the foot. Foot Ankle 1990;10:306-11.

13. Shelton TJ, Singh S, Bent Robinson E, et al. The Influence of Percentage Weight-Bearing on Foot Radiographs. Foot Ankle Spec 2019;12:363-69.

14. Harris RI, Beath T. Etiology of peroneal spastic flat foot. 1948;30B(4):624-634.

15. Taylor JA, Sartoris DJ, Huang GS, Resnick DL. Painful conditions affecting the first metatarsal sesamoid bones. Radiographics. 13(4):817-30, 1993 Jul.Radiographics. 13(4):817-30, 1993 Jul.

16. Wright AA, Hegedus EJ, Lenchik L, Kuhn KJ, Santiago L, Smoliga JM. Diagnostic Accuracy of Various Imaging Modalities for Suspected Lower Extremity Stress Fractures: A Systematic Review With Evidence-Based Recommendations for Clinical Practice. Am J Sports Med 2016;44:255-63.

17. Jain S, Mannan K. The diagnosis and management of Morton's neuroma: a literature review. [Review]. Foot ankle spec.. 6(4):307-17, 2013 Aug.

18. Thomas JL, Christensen JC, Kravitz SR, et al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. [Review] [462 refs]. Journal of Foot & Ankle

Surgery. 49(3 Suppl):S1-19, 2010 May-Jun.J Foot Ankle Surg. 49(3 Suppl):S1-19, 2010 May-Jun.

19. Osborne HR, Breidahl WH, Allison GT. Critical differences in lateral X-rays with and without a diagnosis of plantar fasciitis. J Sci Med Sport. 9(3):231-7, 2006 Jun.

20. Breunung N, Barwick T, Fernando R, et al. Additional benefit of SPECT-CT in investigating heel pain. Clinical Nuclear Medicine. 33(10):705-6, 2008 Oct.Clin Nucl Med. 33(10):705-6, 2008 Oct.

21. 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. 194(6):1575-80, 2010 Jun.

22. Jaffee NW, Gilula LA, Wissman RD, Johnson JE. Diagnostic and therapeutic ankle tenography: outcomes and complications. AJR Am J Roentgenol. 176(2):365-71, 2001 Feb.

23. Fram BR, Rogero R, Fuchs D, Shakked RJ, Raikin SM, Pedowitz DI. Clinical Outcomes and Complications of Peroneal Tendon Sheath Ultrasound-Guided Corticosteroid Injection. Foot Ankle Int 2019;40:888-94.

24. 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.

25. Lee MJ, Kim S, Huh YM, et al. Morton neuroma: evaluated with ultrasonography and MR imaging. Korean J Radiol. 8(2):148-55, 2007 Mar-Apr.

26. Ashman CJ, Klecker RJ, Yu JS. Forefoot pain involving the metatarsal region: differential diagnosis with MR imaging. [Review] [58 refs]. Radiographics. 21(6):1425-40, 2001 Nov-Dec.

27. Terk MR, Kwong PK, Suthar M, Horvath BC, Colletti PM. Morton neuroma: evaluation with MR imaging performed with contrast enhancement and fat suppression. Radiology. 1993;189(1):239-241.

28. Flores DV, Mejia Gomez C, Fernandez Hernando M, Davis MA, Pathria MN. Adult Acquired Flatfoot Deformity: Anatomy, Biomechanics, Staging, and Imaging Findings. [Review]. Radiographics. 39(5):1437-1460, 2019 Sep-Oct.

29. Chang MY, Hong SH, Yoo HJ, Choi JY, Chae HD, Moon SJ. MRI of Cuboid Pulley Lesion. AJR. American Journal of Roentgenology. 211(4):867-871, 2018 10.

30. Khan I, Peters J, Welck M, Saifuddin A. Sinus tarsi and sinus tarsi syndrome: An imaging review. [Review]. European Journal of Radiology. 161:110725, 2023 Apr.

31. Grasel RP, Schweitzer ME, Kovalovich AM, et al. MR imaging of plantar fasciitis: edema, tears, and occult marrow abnormalities correlated with outcome. AJR Am J Roentgenol. 1999 Sep;173(3):699-701.

32. Chimutengwende-Gordon M, O'Donnell P, Singh D. Magnetic resonance imaging in plantar heel pain. Foot Ankle Int. 31(10):865-70, 2010 Oct.

33. Sung W, Weil L Jr, Weil LS Sr, Rolfes RJ. Diagnosis of plantar plate injury by magnetic resonance imaging with reference to intraoperative findings. J Foot Ankle Surg. 51(5):570-4, 2012 Sep-Oct.

34. Albright RH, Brooks BM, Chingre M, Klein EE, Weil LS, Jr., Fleischer AE. Diagnostic accuracy of magnetic resonance imaging (MRI) versus dynamic ultrasound for plantar plate injuries: A systematic review and meta-analysis. Eur J Radiol 2022;152:110315.

35. Kier R, Abrahamian H, Caminear D, et al. MR arthrography of the second and third metatarsophalangeal joints for the detection of tears of the plantar plate and joint capsule. AJR. American Journal of Roentgenology. 194(4):1079-81, 2010 Apr.AJR Am J Roentgenol. 194(4):1079-81, 2010 Apr.

36. Mohana-Borges AV, Theumann NH, Pfirrmann CW, Chung CB, Resnick DL, Trudell DJ. Lesser metatarsophalangeal joints: standard MR imaging, MR arthrography, and MR bursography--initial results in 48 cadaveric joints. Radiology. 227(1):175-82, 2003 Apr.

37. Zanetti M, Strehle JK, Kundert HP, Zollinger H, Hodler J. Morton neuroma: effect of MR imaging findings on diagnostic thinking and therapeutic decisions. Radiology. 213(2):583-8, 1999 Nov.Radiology. 213(2):583-8, 1999 Nov.

38. Zanetti M, Ledermann T, Zollinger H, Hodler J. Efficacy of MR imaging in patients suspected of having Morton's neuroma. AJR. American Journal of Roentgenology. 168(2):529-32, 1997 Feb.AJR Am J Roentgenol. 168(2):529-32, 1997 Feb.

39. Franco H, Pagliaro T, Sparti C, Walsh HJ. Comparing Clinical Examination and Radiological Evaluation in the Preoperative Diagnosis and Location of Symptomatic Interdigital (Morton's) Neuroma. Journal of Foot & Ankle Surgery. 62(5):883-887, 2023 Sep-Oct.

40. Bignotti B, Signori A, Sormani MP, Molfetta L, Martinoli C, Tagliafico A. Ultrasound versus magnetic resonance imaging for Morton neuroma: systematic review and meta-analysis. [Review]. Eur Radiol. 25(8):2254-62, 2015 Aug.

41. Zanetti M, Strehle JK, Zollinger H, Hodler J. Morton neuroma and fluid in the intermetatarsal bursae on MR images of 70 asymptomatic volunteers. Radiology. 1997;203(2):516-520.

42. McCarthy CL, Wilson DJ, Coltman TP. Anterolateral ankle impingement: findings and diagnostic accuracy with ultrasound imaging. Skeletal Radiol. 37(3):209-16, 2008 Mar.

43. Sabir N, Demirlenk S, Yagci B, Karabulut N, Cubukcu S. Clinical utility of sonography in diagnosing plantar fasciitis. J Ultrasound Med. 24(8):1041-8, 2005 Aug.

44. Abdel-Wahab N, Fathi S, Al-Emadi S, Mahdi S. High-resolution ultrasonographic diagnosis of plantar fasciitis: A correlation of ultrasound and magnetic resonance imaging. Int J Rheum Dis 2008;11:279-86.

45. Kapoor A, Sandhu HS, Sandhu PS, Kapoor A, Mahajan G, Kumar A. Realtime elastography in plantar fasciitis: comparison with ultrasonography and MRI. Current Orthopaedic Practice 2010;21:600-08.

46. Draghi F, Gitto S, Bortolotto C, Draghi AG, Ori Belometti G. Imaging of plantar fascia disorders: findings on plain radiography, ultrasound and magnetic resonance imaging. [Review]. Insights Into Imaging. 8(1):69-78, 2017 Feb.Insights imaging. 8(1):69-78, 2017 Feb.

47. Jeswani T, Morlese J, McNally EG. Getting to the heel of the problem: plantar fascia lesions. [Review] [26 refs]. Clin Radiol. 64(9):931-9, 2009 Sep.

48. Sussman WI, Park DJ, Rucci PM, Chen YH. Subluxing fractured plantar fat pad: a case series

and description of novel sonographic findings. Skeletal Radiology. 50(6):1241-1247, 2021 Jun.

49. Feuerstein CA, Weil L Jr, Weil LS Sr, Klein EE, Fleischer A, Argerakis NG. Static Versus Dynamic Musculoskeletal Ultrasound for Detection of Plantar Plate Pathology. Foot & Ankle Specialist. 7(4):259-265, 2014 Jul 15.Foot ankle spec.. 7(4):259-265, 2014 Jul 15.

50. Stone M, Eyler W, Rhodenizer J, van Holsbeeck M. Accuracy of Sonography in Plantar Plate Tears in Cadavers. Journal of Ultrasound in Medicine. 36(7):1355-1361, 2017 Jul.J Ultrasound Med. 36(7):1355-1361, 2017 Jul.

51. Gregg J, Silberstein M, Schneider T, Marks P. Sonographic and MRI evaluation of the plantar plate: A prospective study. Eur Radiol. 2006; 16(12):2661-2669.

52. Xu Z, Duan X, Yu X, Wang H, Dong X, Xiang Z. The accuracy of ultrasonography and magnetic resonance imaging for the diagnosis of Morton's neuroma: a systematic review. [Review]. Clin Radiol. 70(4):351-8, 2015 Apr.

53. Angoules AG, Angoules NA, Georgoudis M, Kapetanakis S. Update on diagnosis and management of cuboid fractures. [Review]. World j. orthop.. 10(2):71-80, 2019 Feb 18.

54. 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. [Review]. Sports med. arthrosc. rev.. 19(2):174-81, 2011 Jun.

55. Chisin R, Peyser A, Milgrom C. Bone scintigraphy in the assessment of the hallucal sesamoids. Foot & Ankle International. 16(5):291-4, 1995 May.Foot Ankle Int. 16(5):291-4, 1995 May.

56. Arican P, Okudan B, Sefizade R, Naldoken S. Diagnostic Value of Bone SPECT/CT in Patients with Suspected Osteomyelitis. Mol Imaging Radionucl Ther. 28(3):89-95, 2019 09 06.

57. Georgoulias P, Georgiadis I, Dimakopoulos N, Mortzos G. Scintigraphy of stress fractures of the sesamoid bones. Clinical Nuclear Medicine. 26(11):944-5, 2001 Nov.Clin Nucl Med. 26(11):944-5, 2001 Nov.

58. Mandell GA, Harcke HT. Scintigraphic manifestations of infraction of the second metatarsal (Freiberg's disease). Journal of Nuclear Medicine. 28(2):249-51, 1987 Feb.J Nucl Med. 28(2):249-51, 1987 Feb.

59. Romanowski CA, Barrington NA. The accessory navicular--an important cause of medial foot pain. Clin Radiol. 1992;46(4):261-264.

60. Chan BY, Markhardt BK, Williams KL, Kanarek AA, Ross AB. Os Conundrum: Identifying Symptomatic Sesamoids and Accessory Ossicles of the Foot. [Review]. AJR. American Journal of Roentgenology. 213(2):417-426, 2019 08.

61. Mosel LD, Kat E, Voyvodic F. Imaging of the symptomatic type II accessory navicular bone. Australas Radiol. 48(2):267-71, 2004 Jun.

62. Jain S, Karunanithi S, Agarwal KK, Kumar G, Roy SG, Tripathi M. Incremental value of single photon emission tomography/computed tomography in 3-phase bone scintigraphy of an accessory navicular bone. Indian Journal of Nuclear Medicine. 29(3):191-2, 2014 Jul.Indian J. Nucl. Med.. 29(3):191-2, 2014 Jul.

63. Usmani S, Sit C, Gnanasegaran G, den Wyngaert TV, Marafi F. Pictorial atlas of

symptomatic accessory ossicles by 18F-Sodium Fluoride (NaF) PET-CT. American Journal of Nuclear Medicine and Molecular Imaging. 7(6):275-282, 2017.

64. Almeida RR, Mansouri M, Tso DK, et al. The added value of cross-sectional imaging in the detection of additional radiographically occult fractures in the setting of a Chopart fracture. EMERG. RADIOL.. 25(5):513-520, 2018 Oct.

65. Choi CH, Ogilvie-Harris DJ. Occult osteochondral fractures of the subtalar joint: a review of 10 patients. J Foot Ankle Surg. 41(1):40-3, 2002 Jan-Feb.

66. Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. AJR Am J Roentgenol. 183(3):615-22, 2004 Sep.

67. Suh CH, Yun SJ, Jin W, Lee SH, Park SY, Ryu CW. Diagnostic performance of dual-energy CT for the detection of bone marrow oedema: a systematic review and meta-analysis. [Review]. Eur Radiol. 28(10):4182-4194, 2018 Oct.

68. Biedert R, Hintermann B. Stress fractures of the medial great toe sesamoids in athletes. Foot & Ankle International. 24(2):137-41, 2003 Feb.Foot Ankle Int. 24(2):137-41, 2003 Feb.

69. Sanders TG, Rathur SK. Imaging of painful conditions of the hallucal sesamoid complex and plantar capsular structures of the first metatarsophalangeal joint. [Review] [37 refs]. Radiol Clin North Am. 46(6):1079-92, vii, 2008 Nov.

70. Chun KA, Oh HK, Wang KH, Suh JS. Freiberg's disease: quantitative assessment of osteonecrosis on three-dimensional CT. J Am Podiatr Med Assoc. 101(4):335-40, 2011 Jul-Aug.

71. Yao L, Do HM, Cracchiolo A, Farahani K. Plantar plate of the foot: findings on conventional arthrography and MR imaging. AJR Am J Roentgenol. 163(3):641-4, 1994 Sep.

72. Mellado JM, Ramos A, Salvado E, Camins A, Danus M, Sauri A. Accessory ossicles and sesamoid bones of the ankle and foot: imaging findings, clinical significance and differential diagnosis. [Review] [30 refs]. Eur Radiol. 13 Suppl 4:L164-77, 2003 Dec.

73. Karasick D, Schweitzer ME. The os trigonum syndrome: imaging features. AJR. 1996;166(1):125-129.

74. Sadineni RT, Pasumarthy A, Bellapa NC, Velicheti S. Imaging Patterns in MRI in Recent Bone Injuries Following Negative or Inconclusive Plain Radiographs. J Clin Diagn Res. 9(10):TC10-3, 2015 Oct.

75. Baker JC, Hoover EG, Hillen TJ, Smith MV, Wright RW, Rubin DA. Subradiographic Foot and Ankle Fractures and Bone Contusions Detected by MRI in Elite Ice Hockey Players. American Journal of Sports Medicine. 44(5):1317-23, 2016 May.Am J Sports Med. 44(5):1317-23, 2016 May.

76. Pierre-Jerome C, Reyes EJ, Moncayo V, Chen ZN, Terk MR. MRI of the cuboid bone: analysis of changes in diabetic versus non-diabetic patients and their clinical significance. Eur J Radiol. 81(10):2771-5, 2012 Oct.

77. Porter DA.. Fifth Metatarsal Jones Fractures in the Athlete. Foot Ankle Int. 39(2):250-258, 2018 02.

78. Karasick D, Schweitzer ME. Disorders of the hallux sesamoid complex: MR features. [Review] [30 refs]. Skeletal Radiology. 27(8):411-8, 1998 Aug.Skeletal Radiol. 27(8):411-8, 1998 Aug.

79. Mateen S, Kwaadu KY, Ali S. Diagnosis, imaging, and potential morbidities of the hallux interphalangeal joint os interphalangeus. [Review]. Skeletal Radiology. 51(6):1143-1151, 2022 Jun.

80. Tafur M, Rosenberg ZS, Bencardino JT. MR Imaging of the Midfoot Including Chopart and Lisfranc Joint Complexes. [Review]. Magnetic Resonance Imaging Clinics of North America. 25(1):95-125, 2017 Feb.Magn Reson Imaging Clin N Am. 25(1):95-125, 2017 Feb.

81. Berman Z, Tafur M, Ahmed SS, Huang BK, Chang EY. Ankle impingement syndromes: an imaging review. [Review]. Br J Radiol. 90(1070):20160735, 2017 Feb.

82. Gregg JM, Schneider T, Marks P. MR imaging and ultrasound of metatarsalgia--the lesser metatarsals. [Review] [50 refs]. Radiol Clin North Am. 46(6):1061-78, vi-vii, 2008 Nov.

83. Couturier S, Gold G. Imaging Features of Avascular Necrosis of the Foot and Ankle. [Review]. Foot & Ankle Clinics. 24(1):17-33, 2019 Mar.

84. Wang CL, Shieh JY, Wang TG, Hsieh FJ. Sonographic detection of occult fractures in the foot and ankle. J Clin Ultrasound. 27(8):421-5, 1999 Oct.

85. Oh SJ, Kim YH, Kim SK, Kim MW. Painful os peroneum syndrome presenting as lateral plantar foot pain. Annals of Rehabilitation Medicine. 36(1):163-6, 2012 Feb.Ann. rehabil. med.. 36(1):163-6, 2012 Feb.

86. van Hasselt AJ, Pustjens J, de Zwart AD, Dal M, de Vries AJ, van Raaij TM. Clinical impact of 99mTc-HDP SPECT/CT imaging as standard workup for foot and ankle osteoarthritis. BJR Open. 5(1):20230017, 2023.

87. Omar IM, Weaver JS, Altbach MI, et al. Imaging of osteoarthritis from the ankle through the midfoot. [Review]. Skeletal Radiology. 52(11):2239-2257, 2023 Nov.Skeletal Radiol. 52(11):2239-2257, 2023 Nov.

88. Steadman J, Sripanich Y, Rungprai C, Mills MK, Saltzman CL, Barg A. Comparative assessment of midfoot osteoarthritis diagnostic sensitivity using weightbearing computed tomography vs weightbearing plain radiography. European Journal of Radiology. 134:109419, 2021 Jan.

89. Richter M, de Cesar Netto C, Lintz F, Barg A, Burssens A, Ellis S. The Assessment of Ankle Osteoarthritis with Weight-Bearing Computed Tomography. [Review]. Foot & Ankle Clinics. 27(1):13-36, 2022 Mar.Foot Ankle Clin. 27(1):13-36, 2022 Mar.

90. Deng E, Gao L, Shi W, et al. Both Magnetic Resonance Imaging and Computed Tomography Are Reliable and Valid in Evaluating Cystic Osteochondral Lesions of the Talus. Orthopaedic Journal of Sports Medicine. 8(9):2325967120946697, 2020 Sep.

91. Ha AS, Cunningham SX, Leung AS, Favinger JL, Hippe DS. Weightbearing Digital Tomosynthesis of Foot and Ankle Arthritis: Comparison With Radiography and Simulated Weightbearing CT in a Prospective Study. AJR. American Journal of Roentgenology. 212(1):173-179, 2019 01.AJR Am J Roentgenol. 212(1):173-179, 2019 01.

92. Khosla S, Thiele R, Baumhauer JF. Ultrasound guidance for intra-articular injections of the foot and ankle. Foot & Ankle International. 30(9):886-90, 2009 Sep.Foot Ankle Int. 30(9):886-90, 2009 Sep.

93. Peterson CK, Buck F, Pfirrmann CW, Zanetti M, Hodler J. Fluoroscopically guided diagnostic and therapeutic injections into foot articulations: report of short-term patient responses

and comparison of outcomes between various injection sites. AJR Am J Roentgenol. 197(4):949-53, 2011 Oct.

94. Saifuddin A, Abdus-Samee M, Mann C, Singh D, Angel JC. CT guided diagnostic foot injections. Clin Radiol. 60(2):191-5, 2005 Feb.

95. Khoury NJ, el-Khoury GY, Saltzman CL, Brandser EA. Intraarticular foot and ankle injections to identify source of pain before arthrodesis. AJR. 1996;167(3):669-673.

96. Camerer M, Ehrenstein B, Hoffstetter P, Fleck M, Hartung W. High-resolution ultrasound of the midfoot: sonography is more sensitive than conventional radiography in detection of osteophytes and erosions in inflammatory and non-inflammatory joint disease. Clinical Rheumatology. 36(9):2145-2149, 2017 Sep.Clin Rheumatol. 36(9):2145-2149, 2017 Sep.

97. Zubler V, Zanetti M, Dietrich TJ, Espinosa N, Pfirrmann CW, Mamisch-Saupe N. Is there an Added Value of T1-Weighted Contrast-Enhanced Fat-suppressed Spin-Echo MR Sequences Compared to STIR Sequences in MRI of the Foot and Ankle?. European Radiology. 27(8):3452-3459, 2017 Aug.

98. Nevalainen MT, Pitkanen MM, Saarakkala S. Diagnostic Performance of Ultrasonography for Evaluation of Osteoarthritis of Ankle Joint: Comparison With Radiography, Cone-Beam CT, and Symptoms. Journal of Ultrasound in Medicine. 41(5):1139-1146, 2022 May.J Ultrasound Med. 41(5):1139-1146, 2022 May.

99. Peterson JJ, Bancroft LW, Kransdorf MJ. Wooden foreign bodies: imaging appearance. AJR. American Journal of Roentgenology. 178(3):557-62, 2002 Mar.AJR Am J Roentgenol. 178(3):557-62, 2002 Mar.

100. Aras MH, Miloglu O, Barutcugil C, Kantarci M, Ozcan E, Harorli A. Comparison of the sensitivity for detecting foreign bodies among conventional plain radiography, computed tomography and ultrasonography. Dentomaxillofac Radiol. 2010;39(2):72-78.

101. Jarraya M, Hayashi D, de Villiers RV, et al. Multimodality imaging of foreign bodies of the musculoskeletal system. [Review]. AJR Am J Roentgenol. 203(1):W92-102, 2014 Jul.

102. Hoffstetter P, Friedrich C, Framme C, et al. [Detection of intraorbital foreign material using MDCT]. Rofo 2011;183:543-8.

103. Ruder TD, Thali Y, Bolliger SA, et al. Material differentiation in forensic radiology with single-source dual-energy computed tomography. Forensic Sci Med Pathol 2013;9:163-9.

104. Carneiro BC, Cruz IAN, Chemin RN, et al. Multimodality Imaging of Foreign Bodies: New Insights into Old Challenges. [Review]. Radiographics. 40(7):1965-1986, 2020 Nov-Dec.Radiographics. 40(7):1965-1986, 2020 Nov-Dec.

105. Monu JU, McManus CM, Ward WG, Haygood TM, Pope TL, Jr., Bohrer SP. Soft-tissue masses caused by long-standing foreign bodies in the extremities: MR imaging findings. AJR Am J Roentgenol 1995;165:395-7.

106. Murakami AM, Chang A, Foo LF. Traumatic Lateral Plantar Artery Pseudoaneurysm and the Use of Time-Resolved MR Angiography. HSS J 2010;6:214-8.

107. Karcnik TJ, Nazarian LN, Rao VM, Gibbons GE, Jr. Foreign body granuloma simulating solid neoplasm on MR. Clin Imaging 1997;21:269-72.

108. Hunter TB, Taljanovic MS. Foreign bodies. Radiographics 2003;23:731-57.

109. Boyse TD, Fessell DP, Jacobson JA, Lin J, van Holsbeeck MT, Hayes CW. US of soft-tissue foreign bodies and associated complications with surgical correlation. Radiographics 2001;21:1251-6.

110. Bray PW, Mahoney JL, Campbell JP. Sensitivity and specificity of ultrasound in the diagnosis of foreign bodies in the hand. J Hand Surg Am 1995;20:661-6.

111. Jacobson JA, Powell A, Craig JG, Bouffard JA, van Holsbeeck MT. Wooden foreign bodies in soft tissue: detection at US. Radiology. 1998;206(1):45-48.

112. Horton LK, Jacobson JA, Powell A, Fessell DP, Hayes CW. Sonography and radiography of soft-tissue foreign bodies. AJR Am J Roentgenol 2001;176:1155-9.

113. Rubin JM, Adler RS, Bude RO, Fowlkes JB, Carson PL. Clean and dirty shadowing at US: a reappraisal. Radiology 1991;181:231-6.

114. Davae KC, Sofka CM, DiCarlo E, Adler RS. Value of power Doppler imaging and the hypoechoic halo in the sonographic detection of foreign bodies: correlation with histopathologic findings. Journal of Ultrasound in Medicine. 22(12):1309-13; quiz 1314-6, 2003 Dec.J Ultrasound Med. 22(12):1309-13; quiz 1314-6, 2003 Dec.

115. Cappello ZJ, Kasdan ML, Louis DS. Meta-analysis of imaging techniques for the diagnosis of complex regional pain syndrome type I. [Review]. J Hand Surg [Am]. 37(2):288-96, 2012 Feb.

116. Flanigan RM, DiGiovanni BF. Peripheral nerve entrapments of the lower leg, ankle, and foot. Foot Ankle Clin 2011;16:255-74.

117. Nwawka OK, Miller TT. Ultrasound-Guided Peripheral Nerve Injection Techniques. AJR Am J Roentgenol 2016;207:507-16.

118. Borchers AT, Gershwin ME. Complex regional pain syndrome: a comprehensive and critical review. [Review]. Autoimmun Rev. 13(3):242-65, 2014 Mar.

119. Schurmann M, Zaspel J, Lohr P, et al. Imaging in early posttraumatic complex regional pain syndrome: a comparison of diagnostic methods. Clin J Pain. 23(5):449-57, 2007 Jun.

120. Schweitzer ME, Mandel S, Schwartzman RJ, Knobler RL, Tahmoush AJ. Reflex sympathetic dystrophy revisited: MR imaging findings before and after infusion of contrast material. Radiology. 1995;195(1):211-214.

121. Agten CA, Kobe A, Barnaure I, Galley J, Pfirrmann CW, Brunner F. MRI of complex regional pain syndrome in the foot. European Journal of Radiology. 129:109044, 2020 Aug.

122. Garwood ER, Duarte A, Bencardino JT. MR Imaging of Entrapment Neuropathies of the Lower Extremity. [Review]. Radiol Clin North Am. 56(6):997-1012, 2018 Nov.

123. Kim SJ, Hong SH, Jun WS, et al. MR imaging mapping of skeletal muscle denervation in entrapment and compressive neuropathies. [Review]. Radiographics. 31(2):319-32, 2011 Mar-Apr.

124. De Maeseneer M, Madani H, Lenchik L, et al. Normal Anatomy and Compression Areas of Nerves of the Foot and Ankle: US and MR Imaging with Anatomic Correlation. [Review]. Radiographics. 35(5):1469-82, 2015 Sep-Oct.

125. Schmid DT, Hodler J, Mengiardi B, Pfirrmann CW, Espinosa N, Zanetti M. Fatty muscle atrophy: prevalence in the hindfoot muscles on MR images of asymptomatic volunteers

and patients with foot pain. Radiology. 253(1):160-6, 2009 Oct.

126. Chari B, McNally E. Nerve Entrapment in Ankle and Foot: Ultrasound Imaging. [Review]. Seminars in Musculoskeletal Radiology. 22(3):354-363, 2018 Jul.

127. Presley JC, Maida E, Pawlina W, Murthy N, Ryssman DB, Smith J. Sonographic visualization of the first branch of the lateral plantar nerve (baxter nerve): technique and validation using perineural injections in a cadaveric model. J Ultrasound Med. 32(9):1643-52, 2013 Sep.

128. Nazarian LN, Schweitzer ME, Mandel S, et al. Increased soft-tissue blood flow in patients with reflex sympathetic dystrophy of the lower extremity revealed by power Doppler sonography. AJR. 1998;171(5):1245-1250.

129. National Academies of Sciences, Engineering, and Medicine; Division of Behavioral and Social Sciences and Education; Committee on National Statistics; Committee on Measuring Sex, Gender Identity, and Sexual Orientation. Measuring Sex, Gender Identity, and Sexual Orientation. In: Becker T, Chin M, Bates N, eds. Measuring Sex, Gender Identity, and Sexual Orientation. Washington (DC): National Academies Press (US) Copyright 2022 by the National Academy of Sciences. All rights reserved.; 2022.

130. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf.

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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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