

**American College of Radiology  
ACR Appropriateness Criteria®  
Chronic Foot Pain**

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

Procedure	Appropriateness Category	Relative Radiation Level
Radiography foot	Usually Appropriate	⊕
US foot	Usually Not Appropriate	○
MRI foot without and with IV contrast	Usually Not Appropriate	○
MRI foot without IV contrast	Usually Not 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	⊕⊕⊕

**Variant 2:                      Persistent posttraumatic foot pain. Radiographs negative or equivocal. Clinical concern includes complex regional pain syndrome type I. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	○
3-phase bone scan foot	Usually Appropriate	⊕⊕⊕
MRI foot without and with IV contrast	May Be Appropriate	○
US foot	Usually Not 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	⊕

**Variant 3:                      Chronic metatarsalgia including plantar great toe pain. Radiographs negative or equivocal. Clinical concern includes sesamoiditis, Morton's neuroma, intermetatarsal bursitis, chronic plantar plate injury, or Freiberg's infraction. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	○
US foot	May Be Appropriate	○
MRI foot without and with IV contrast	May Be Appropriate	○
CT foot without IV contrast	May Be Appropriate	⊕
Bone scan foot	May Be Appropriate	⊕⊕⊕
CT foot with IV contrast	Usually Not Appropriate	⊕
CT foot without and with IV contrast	Usually Not Appropriate	⊕

**Variant 4:**

**Chronic plantar heel pain. Radiographs negative or equivocal. Clinical concern includes plantar fasciitis or plantar fascia tear. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US foot	Usually Appropriate	○
MRI foot without IV contrast	Usually Appropriate	○
MRI foot without and with IV contrast	Usually Not 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 with SPECT or SPECT/CT foot	Usually Not Appropriate	⊕⊕⊕

**Variant 5:**

**Nonradiating chronic midfoot pain of suspected osseous origin. Radiographs negative or equivocal. Clinical concern includes occult fracture, or painful accessory ossicles. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without IV contrast	Usually Appropriate	○
CT foot without IV contrast	Usually Appropriate	⊕
Bone scan foot	May Be Appropriate	⊕⊕⊕
US foot	Usually Not Appropriate	○
MRI foot without and with IV contrast	Usually Not Appropriate	○
CT foot with IV contrast	Usually Not Appropriate	⊕
CT foot without and with IV contrast	Usually Not Appropriate	⊕

**Variant 6:**

**Chronic foot pain. Entrapment syndromes. Radiographs negative or equivocal. Clinical concern includes Baxter's neuropathy. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US foot	Usually Appropriate	○
MRI foot without IV contrast	Usually Appropriate	○
MRI foot without and with IV contrast	Usually Not Appropriate (Disagreement)	○
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 with SPECT or SPECT/CT foot	Usually Not Appropriate	⊕⊕⊕

## CHRONIC FOOT PAIN

Expert Panel on Musculoskeletal Imaging: Monica Tafur, MD<sup>a</sup>; Jenny T. Bencardino, MD<sup>b</sup>; Catherine C. Roberts, MD<sup>c</sup>; Marc Appel, MD<sup>d</sup>; Angela M. Bell, MD<sup>e</sup>; Soterios Gyftopoulos, MD, MSc<sup>f</sup>; Darlene F. Metter, MD<sup>g</sup>; Douglas N. Mintz, MD<sup>h</sup>; William B. Morrison, MD<sup>i</sup>; Kirstin M. S. Small, MD, MBA<sup>j</sup>; Naveen Subhas, MD, MPH<sup>k</sup>; Barbara N. Weissman, MD<sup>l</sup>; Joseph S. Yu, MD<sup>m</sup>; Mark J. Kransdorf, MD.<sup>n</sup>

### Summary of Literature Review

#### **Introduction/Background**

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 [1,2]. Randomized controlled trials have demonstrated a significant improvement in health-related quality of life with effective treatment of foot pain [3]. 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 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 [4]. 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 [1].

The guidelines of the American College of Foot and Ankle Surgeons divide heel pain into plantar heel pain, usually related to pathology of the plantar fascia, and posterior heel pain, usually related to pathology of the Achilles tendon, and treatment options vary from nonoperative treatments to surgical procedures [5].

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<sup>®</sup> topic on “[Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus](#)” [6]. Posttraumatic entities affecting the ankle, including instability, arthrosis, osteochondral defects, osteonecrosis, and tendinopathies, are discussed in ACR Appropriateness Criteria<sup>®</sup> topic on “[Chronic Ankle Pain](#)” [7]. Infectious and inflammatory arthropathies are discussed in ACR Appropriateness Criteria<sup>®</sup> topics on “[Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection \(Excluding Spine and Diabetic Foot\)](#)” [8] and “[Chronic Extremity Joint Pain–Suspected Inflammatory Arthritis](#)” [9]. Acute traumatic injuries of the foot including Lisfranc injuries are discussed in ACR Appropriateness Criteria<sup>®</sup> topic on “[Acute Trauma to the Foot](#)” [10].

#### **Initial Imaging Definition**

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

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

OR

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

<sup>a</sup>University of Toronto, Toronto, Ontario, Canada. <sup>b</sup>New York University School of Medicine, New York, New York. <sup>c</sup>Panel Chair, vRad, a MEDNAX Company, Eden Prairie, Minnesota. <sup>d</sup>James J. Peters VA Medical Center, Bronx, New York; American Academy of Orthopaedic Surgeons. <sup>e</sup>Rush University Medical Center, Chicago, Illinois; American College of Physicians. <sup>f</sup>New York University Medical Center, New York, New York. <sup>g</sup>UT Health San Antonio, San Antonio, Texas. <sup>h</sup>Hospital for Special Surgery, New York, New York. <sup>i</sup>Thomas Jefferson University Hospital, Philadelphia, Pennsylvania. <sup>j</sup>Brigham & Women’s Hospital, Boston, Massachusetts. <sup>k</sup>Cleveland Clinic, Cleveland, Ohio. <sup>l</sup>Harvard Medical School, Boston, Massachusetts. <sup>m</sup>The Ohio State University Wexner Medical Center, Columbus, Ohio. <sup>n</sup>Specialty Chair, Mayo Clinic, Phoenix, Arizona.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Reprint requests to: [publications@acr.org](mailto:publications@acr.org)

## **Discussion of Procedures by Variant**

### **Variant 1: Chronic foot pain. Unknown etiology. Initial imaging.**

#### **Bone Scan Foot**

There is no relevant literature to support the use of nuclear medicine studies as the first imaging study in the evaluation of chronic foot pain.

#### **CT Foot**

There is no relevant literature to support the use of CT as the first imaging study in the evaluation of chronic foot pain.

#### **MRI Foot**

There is no relevant literature to support the use of MRI as the first imaging study in the evaluation of chronic foot pain.

#### **Radiography Foot**

Conventional radiography can be useful to distinguish among different causes of chronic foot pain and is usually the first imaging study in evaluating patients with chronic foot pain.

The value of radiographs in the diagnosis of tarsal coalitions has been extensively demonstrated. Overall sensitivities range from 80% to 100% and specificities range from 97% to 98% have been reported for radiographs in the diagnosis of calcaneonavicular coalitions. Most calcaneonavicular coalitions are easily detected on lateral and oblique radiographs of the foot and confirmed on sagittal CT or MRI scans [11]. 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 talocalcaneal coalitions [12]. CT and MRI remain the most reliable methods for diagnosing subtalar coalitions.

Radiographs are usually performed initially in the clinical setting of a suspected stress fracture. A systematic review by Wright et al [13] 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 represent the first imaging study usually performed to evaluate the first metatarsal sesamoids and may be useful to diagnose sesamoid dislocation, osteoarthritis, or to distinguish between bipartite 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 [12]. Radiographs are insensitive to diagnose Morton's neuroma but are useful to exclude other causes of webspace pain such as osteoarthritis, Freiberg's infraction, and stress fractures. Splaying of the metatarsals or soft-tissue density may be demonstrated but are not diagnostic [14].

Though radiography is typically insensitive in the diagnosis of fasciitis, it should be the initial imaging study in patients with a painful heel. Evidence supports the use of weightbearing radiographs in this instance [5]. 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 [15].

#### **US Foot**

Ultrasound (US) is usually not indicated as the first imaging study in the evaluation of chronic foot pain, but may be performed 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's neuroma, plantar plate tears, and intermetatarsal bursitis.

### **Variant 2: Persistent posttraumatic foot pain. Radiographs negative or equivocal. Clinical concern includes complex regional pain syndrome type I. Next imaging study.**

#### **3-Phase Bone Scan Foot**

A 3-phase bone scan may be useful in cases of suspected complex regional pain syndrome (CRPS) type I reflex sympathetic dystrophy, and 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 negative predictive value (NPV; 100%) when compared to MRI and conventional radiography, and therefore, it may be useful to rule-out disease [16]. A meta-analysis by Cappello et al [17] demonstrated a pooled sensitivity, specificity, NPV, and positive predictive value (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.

#### **CT Foot**

There is no relevant literature to support the use of CT in the evaluation of suspected CRPS.

#### **MRI Foot**

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 [18]. Several findings have been described on MRI in patients with early and advanced CRPS type I reflex sympathetic dystrophy [19,20]. In general, MRI has been found to be a specific but nonsensitive method in the diagnosis of CRPS type I. In a study by Schürmann et al [19], 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 [20] demonstrated higher sensitivity (87%) and PPV (100%) for contrast-enhanced MRI. A meta-analysis by Cappello et al [17] reported pooled specificity, sensitivity, NPV, and PPV for MRI in the diagnosis of CRPS type I of 91%, 35%, 51%, and 64%, respectively. 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 may be useful in cases of CRPS type II [21].

#### **US Foot**

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 subjects with a sensitivity of 73% and specificity of 92% [22]. 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 [23].

**Variant 3: Chronic metatarsalgia including plantar great toe pain. Radiographs negative or equivocal. Clinical concern includes sesamoiditis, Morton's neuroma, intermetatarsal bursitis, chronic plantar plate injury, or Freiberg's infraction. Next imaging study.**

#### **Bone Scan Foot**

Planar bone scintigraphy has low anatomic resolution and has been shown to be a nonspecific technique to assess the hallucal sesamoids [24]. However, bone scintigraphy with single-photon emission computed tomography (SPECT)/CT increases contrast resolution and anatomic localization of foci with increased osteoblastic activity [25]. 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 [26]. When an indeterminate linear lucency is visualized on radiographs, a negative bone scintigraphy suggests sesamoid bipartition [12]. Other conditions that may present positive findings on Tc-99m-methylene diphosphonate (MDP) bone scintigraphy include sesamoiditis, inflammatory or deposition arthropathies, osteoarthritis, and osteonecrosis [39]. In Freiberg's infraction, a photopenic center with a hyperactive collar may be identified on early stages on high-resolution Tc-99m-MDP bone scintigraphy [27].

#### **CT Foot**

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 [28]. 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 osteoarthritis can also be assessed with CT [29]. CT is considered a useful and reliable method to determine the extent of necrosis in Freiberg's infraction, which represents the main determining factor in the outcome [30]. 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 [31].

#### **MRI Foot**

MRI is useful in the diagnosis of several conditions affecting the hallucal sesamoid bones, including fractures, acute and chronic stress related changes, and avascular necrosis, and a variety of MRI findings have been described in the literature [12]. Contrast administration is not routinely performed in the assessment of noninfectious and/or

nontumoral conditions affecting the hallux sesamoids; however, it could be useful to distinguish between sesamoiditis and avascular necrosis [32,33].

The most commonly used imaging techniques in the diagnosis of Morton's 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 and change in treatment [34]. MRI is believed to be a sensitive and reliable method to evaluate patients with metatarsalgia and Morton's neuroma with a sensitivity of 87%, specificity of 100%, accuracy of 89%, PPV of 100%, and NPV of 60% in surgically treated patients [35]. 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 [36]. Increased fluid within the intermetatarsal bursa, which suggests bursitis, is well demonstrated on MRI [37]. Although the use of gadolinium does not seem essential to detect Morton's neuromas [38], it may facilitate its detection because of the improved soft-tissue contrast [32,39].

MRI is widely accepted as the imaging study of choice for diagnosis of plantar plate tears. In a prospective study, Sung et al [40] found high accuracy (96%), sensitivity (95%), specificity (100%), PPV (100%), and 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 sensitivity and specificity for MRI of 95% and 54%, respectively [41]. MR arthrography improves visualization of pericapsular structures when compared to conventional MRI and therefore is useful in the diagnosis and characterization of plantar plate tears and abnormalities of related structures [42,43].

MRI may be helpful to diagnose Freiberg's infraction and several nonspecific findings have been described in early and chronic stages [32,44]. There is no evidence in the literature supporting the routine use of contrast in the setting of avascular necrosis [45].

#### **US Foot**

There is limited information available in the literature regarding the use of US in the diagnosis of sesamoiditis. US has been shown to be useful in diagnosing tears of the sesamoid phalangeal ligament in the setting of turf toe [46].

Morton's neuroma and fluid-filled intermetatarsal bursae can be demonstrated on US. High-resolution US can approach the sensitivity of MRI in detecting Morton's neuromas. Similar to MRI, US is considered a reliable method to evaluate patients with Morton's neuroma. 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 two modalities were found in a meta-analysis [36]. Other authors have found higher diagnostic capabilities of US over MRI in the diagnosis of Morton's 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 [47].

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 [48]. With MRI as the reference standard, Gregg et al [49] 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 [41].

**Variant 4: Chronic plantar heel pain. Radiographs negative or equivocal. Clinical concern includes plantar fasciitis or plantar fascia tear. Next imaging study.**

#### **Bone Scan Foot with SPECT or SPECT/CT**

SPECT/CT has been found to be of use when investigating heel pain with increased specificity when compared to bone scintigraphy alone, because of the improved anatomic localization of metabolic activity. Despite the anatomic and functional advantages of SPECT/CT, MRI and high-frequency US remain the most frequently used imaging modalities in patients with heel pain [50]. 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 [51]. There is no relevant literature to support the routine use of nuclear medicine studies to diagnose plantar fascial tears.

### **CT Foot**

There is no relevant literature to support the routine use of CT in the evaluation of a patient with clinical suspicion of pathology of the plantar fascia.

### **MRI Foot**

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 [52]. Given that, some of the findings in patients with plantar fasciitis are nonspecific; these findings can also be seen in asymptomatic patients. MRI should always be correlated with clinical symptoms to avoid overcalling plantar fasciitis. 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 [53]. There is no relevant literature supporting the routine use of contrast in the diagnosis of plantar fasciitis or tears.

### **US Foot**

US has shown good sensitivity (80%) and specificity (88%) in the diagnosis of plantar fasciitis when compared to MRI [54]. 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 [55]. Kapoor et al [56] showed higher sensitivity and specificity of US elastography when compared to 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 [57]. Some authors regard US to be superior to MRI in differentiating true fiber interruption and tearing of the plantar fascia from edema [58].

**Variant 5: Nonradiating chronic midfoot pain of suspected osseous origin. Radiographs negative or equivocal. Clinical concern includes occult fracture, or painful accessory ossicles. Next imaging study.**

### **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 [59]. SPECT/CT may improve the diagnosis of patients with suspected fractures because of the more precise anatomical localization [60].

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 reaction [61]. A negative bone scan can exclude the presence of a symptomatic accessory ossicle, but positive findings lack specificity [62]. 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 [63].

### **CT Foot**

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 utility 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 the presence of an accessory ossicle, os fragmentation or fracture, intra-articular bodies, or osteochondral abnormalities. 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 to MRI [68].

There is no relevant literature supporting the routine use of contrast-enhanced CT images in the diagnosis of occult fractures or symptomatic accessory ossicles, besides a possible use of CT arthrography to demonstrate disruption of the synchondrosis in the setting of os trigonum syndrome [69].

## **MRI Foot**

MRI allows the visualization of bone marrow edema patterns, which improves the detection of fractures in cases of negative or inconclusive radiographs [70]. The utility of MRI in the detection of radiographically occult Chopart fractures has been demonstrated by Almeida et al [64]. Baker et al [71] analyzed 31 occult fractures involving the ankle and foot in hockey players, finding five occult fractures in the foot, all of which involved the navicular bone. Pierre-Jerome et al [72] 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 [65,73]. There is no evidence in the literature supporting the routine use of contrast in the diagnosis of occult fractures.

MRI has replaced bone scans in the evaluation of 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, which is also well assessed on MRI [74]. MRI allows clear demonstration of the findings often associated with posterior ankle impingement syndrome [75]. Contrast administration is not routinely performed when assessing symptomatic accessory ossicles on MRI; however, contrast within a disrupted synchondrosis may be demonstrated on MR arthrography studies [69].

## **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 [76] 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 [62]. High-resolution US offers some advantages over other imaging modalities because it allows dynamic exploration of the foot with further assessment of stability of the synchondrosis and tendon tears when present as well as direct clinical correlation and comparative evaluation with the asymptomatic foot [77]. Power Doppler US has proven useful in identifying increased blood supply in the setting of ankle impingement [78,79].

**VARIANT 6: Chronic foot pain. Entrapment syndromes. Radiographs negative or equivocal. Clinical concern includes Baxter's neuropathy. Next imaging study.**

### **Bone Scan Foot with SPECT/CT**

There is no relevant literature supporting the use of nuclear medicine studies in the diagnosis of Baxter's neuropathy.

### **CT Foot**

There is no relevant literature supporting the use of CT, either with or without contrast in the diagnosis of Baxter's neuropathy.

### **MRI Foot**

Compression of the inferior calcaneal nerve or Baxter's 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's neuropathy and in the exclusion of other causes of foot pain [23]. However, fatty atrophy of the abductor digiti minimi muscle is not a specific sign of Baxter's neuropathy and can be found in 4% of asymptomatic subjects [80]. Contrast administration is not routinely performed in the initial assessment of neuropathic syndromes.

### **US Foot**

Compression of the inferior calcaneal nerve or Baxter's 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 [23]. Presley et al [81] 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.

## **Summary of Recommendations**

- **VARIANT 1:** Radiography foot is usually appropriate for the initial imaging of chronic foot pain of unknown etiology.



- **Variation 2:** MRI foot without IV contrast or 3-phase bone scan foot is usually appropriate as the next imaging study after negative or equivocal radiographs in patients with persistent posttraumatic foot pain when clinical concern includes CRPS type I. Bone scan may be useful to exclude this condition, and enhanced MRI may assist in the diagnosis.
- **Variation 3:** MRI foot without IV contrast is usually appropriate as the next imaging study after negative or equivocal radiographs in patients with chronic metatarsalgia, including plantar great toe pain, when clinical concern includes sesamoiditis, Morton’s neuroma, intermetatarsal bursitis, chronic plantar plate injury, or Freiberg’s infraction.
- **Variation 4:** MRI foot without IV contrast or US foot is usually appropriate as the next imaging study after negative or equivocal radiographs in patients with chronic plantar heel pain when clinical concern includes plantar fasciitis or plantar fascia tear.
- **Variation 5:** MRI foot without IV contrast or CT foot without IV contrast is usually appropriate as the next imaging study after negative or equivocal radiographs in patients with nonradiating chronic midfoot pain of suspected osseous origin when clinical concern includes occult fracture or painful accessory ossicles.
- **Variation 6:** MRI foot without IV contrast or US foot is usually appropriate as the next imaging study after negative or equivocal radiographs in patients with chronic foot pain resulting from entrapment syndromes when clinical concern includes Baxter’s neuropathy.

**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 go to [www.acr.org/ac](http://www.acr.org/ac).

**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 [82].

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

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

## References

1. Joong MA, El-Khoury GY. Radiologic evaluation of chronic foot pain. *Am Fam Physician* 2007;76:975-83.
2. Hawke F, Burns J. Understanding the nature and mechanism of foot pain. *J Foot Ankle Res* 2009;2:1.
3. Hawke F, Burns J, Radford JA, du Toit V. Custom-made foot orthoses for the treatment of foot pain. *Cochrane Database Syst Rev* 2008:CD006801.
4. Menz HB. Chronic foot pain in older people. *Maturitas* 2016;91:110-4.
5. Thomas JL, Christensen JC, Kravitz SR, et al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. *J Foot Ankle Surg* 2010;49:S1-19.
6. 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.
7. Chang EY, Tadros AS, Amini B, et al. ACR Appropriateness Criteria® Chronic Ankle Pain. *J Am Coll Radiol* 2018;15:S26-S38.
8. Beaman FD, von Herrmann PF, Kransdorf MJ, et al. ACR Appropriateness Criteria® Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot). *J Am Coll Radiol* 2017;14:S326-S37.
9. Jacobson JA, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria® Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis. *J Am Coll Radiol* 2017;14:S81-S89.
10. American College of Radiology. ACR Appropriateness Criteria®: Acute Trauma to the Foot. Available at: <https://acsearch.acr.org/docs/70546/Narrative/>. Accessed March 27, 2020.
11. Harris RI, Beath T. Etiology of peroneal spastic flat foot. *The Journal of bone and joint surgery. British volume* 1948;30B:624-34.
12. Taylor JA, Sartoris DJ, Huang GS, Resnick DL. Painful conditions affecting the first metatarsal sesamoid bones. *Radiographics* 1993;13:817-30.
13. 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.
14. Jain S, Mannan K. The diagnosis and management of Morton's neuroma: a literature review. *Foot Ankle Spec* 2013;6:307-17.
15. Osborne HR, Breidahl WH, Allison GT. Critical differences in lateral X-rays with and without a diagnosis of plantar fasciitis. *J Sci Med Sport* 2006;9:231-7.
16. Holder LE, Cole LA, Myerson MS. Reflex sympathetic dystrophy in the foot: clinical and scintigraphic criteria. *Radiology* 1992;184:531-5.

17. Cappello ZJ, Kasdan ML, Louis DS. Meta-analysis of imaging techniques for the diagnosis of complex regional pain syndrome type I. *J Hand Surg Am* 2012;37:288-96.
18. Borchers AT, Gershwin ME. Complex regional pain syndrome: a comprehensive and critical review. *Autoimmun Rev* 2014;13:242-65.
19. Schürmann M, Zaspel J, Löhr P, et al. Imaging in early posttraumatic complex regional pain syndrome- a comparison of diagnostic methods. *Clin J Pain* 2007;23:449-57.
20. Schweitzer ME, Mandel S, Schwartzman RJ, Knobler RL, Tahmouh AJ. Reflex sympathetic dystrophy revisited: MR imaging findings before and after infusion of contrast material. *Radiology* 1995;195:211-4.
21. Garwood ER, Duarte A, Bencardino JT. MR Imaging of Entrapment Neuropathies of the Lower Extremity. *Radiol Clin North Am* 2018;56:997-1012.
22. 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 Am J Roentgenol* 1998;171:1245-50.
23. 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. *Radiographics* 2015;35:1469-82.
24. Chisin R, Peyser A, Milgrom C. Bone scintigraphy in the assessment of the hallual sesamoids. *Foot Ankle Int* 1995;16:291-4.
25. Arican P, Okudan B, Sefizade R, Naldoken S. Diagnostic Value of Bone SPECT/CT in Patients with Suspected Osteomyelitis. *Mol Imaging Radionucl Ther* 2019;28:89-95.
26. Georgoulas P, Georgiadis I, Dimakopoulos N, Mortzos G. Scintigraphy of stress fractures of the sesamoid bones. *Clin Nucl Med* 2001;26:944-5.
27. Mandell GA, Harecke HT. Scintigraphic manifestations of infraction of the second metatarsal (Freiberg's disease). *J Nucl Med* 1987;28:249-51.
28. Biedert R, Hintermann B. Stress fractures of the medial great toe sesamoids in athletes. *Foot Ankle Int* 2003;24:137-41.
29. Sanders TG, Rathur SK. Imaging of painful conditions of the hallual sesamoid complex and plantar capsular structures of the first metatarsophalangeal joint. *Radiol Clin North Am* 2008;46:1079-92, vii.
30. Chun KA, Oh HK, Wang KH, Suh JS. Freiberg's disease: quantitative assessment of osteonecrosis on three-dimensional CT. *J Am Podiatr Med Assoc* 2011;101:335-40.
31. Yao L, Do HM, Cracchiolo A, Farahani K. Plantar plate of the foot: findings on conventional arthrography and MR imaging. *AJR Am J Roentgenol* 1994;163:641-4.
32. Ashman CJ, Klecker RJ, Yu JS. Forefoot pain involving the metatarsal region: differential diagnosis with MR imaging. *Radiographics* 2001;21:1425-40.
33. Karasick D, Schweitzer ME. Disorders of the hallux sesamoid complex: MR features. *Skeletal Radiol* 1998;27:411-8.
34. Zanetti M, Strehle JK, Kundert HP, Zollinger H, Hodler J. Morton neuroma: effect of MR imaging findings on diagnostic thinking and therapeutic decisions. *Radiology* 1999;213:583-8.
35. Zanetti M, Ledermann T, Zollinger H, Hodler J. Efficacy of MR imaging in patients suspected of having Morton's neuroma. *AJR Am J Roentgenol* 1997;168:529-32.
36. 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. *Eur Radiol* 2015;25:2254-62.
37. 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;203:516-20.
38. Lee MJ, Kim S, Huh YM, et al. Morton neuroma: evaluated with ultrasonography and MR imaging. *Korean J Radiol* 2007;8:148-55.
39. 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;189:239-41.
40. 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* 2012;51:570-4.
41. Duan X, Li L, Wei DQ, et al. Role of magnetic resonance imaging versus ultrasound for detection of plantar plate tear. *J Orthop Surg Res* 2017;12:14.
42. 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 Am J Roentgenol* 2010;194:1079-81.

43. 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* 2003;227:175-82.
44. Gregg JM, Schneider T, Marks P. MR imaging and ultrasound of metatarsalgia--the lesser metatarsals. *Radiol Clin North Am* 2008;46:1061-78, vi-vii.
45. Couturier S, Gold G. Imaging Features of Avascular Necrosis of the Foot and Ankle. *Foot Ankle Clin* 2019;24:17-33.
46. 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 Spec* 2014;7:259-65.
47. 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. *Clin Radiol* 2015;70:351-8.
48. Stone M, Eyster W, Rhodenizer J, van Holsbeeck M. Accuracy of Sonography in Plantar Plate Tears in Cadavers. *J Ultrasound Med* 2017;36:1355-61.
49. Gregg J, Silberstein M, Schneider T, Marks P. Sonographic and MRI evaluation of the plantar plate: A prospective study. *Eur Radiol* 2006;16:2661-9.
50. Breunung N, Barwick T, Fernando R, et al. Additional benefit of SPECT-CT in investigating heel pain. *Clin Nucl Med* 2008;33:705-6.
51. Intenzo CM, Wapner KL, Park CH, Kim SM. Evaluation of plantar fasciitis by three-phase bone scintigraphy. *Clin Nucl Med* 1991;16:325-8.
52. 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;173:699-701.
53. Chimutengwende-Gordon M, O'Donnell P, Singh D. Magnetic resonance imaging in plantar heel pain. *Foot Ankle Int* 2010;31:865-70.
54. Sabir N, Demirlenk S, Yagci B, Karabulut N, Cubukcu S. Clinical utility of sonography in diagnosing plantar fasciitis. *J Ultrasound Med* 2005;24:1041-8.
55. 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.
56. 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.
57. 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. *Insights Imaging* 2017;8:69-78.
58. Jeswani T, Morlese J, McNally EG. Getting to the heel of the problem: plantar fascia lesions. *Clin Radiol* 2009;64:931-9.
59. Angoules AG, Angoules NA, Georgoudis M, Kapetanakis S. Update on diagnosis and management of cuboid fractures. *World J Orthop* 2019;10:71-80.
60. Hirschmann MT, Davda K, Rasch H, Arnold MP, Friederich NF. Clinical value of combined single photon emission computerized tomography and conventional computer tomography (SPECT/CT) in sports medicine. *Sports Med Arthrosc Rev* 2011;19:174-81.
61. Romanowski CA, Barrington NA. The accessory navicular--an important cause of medial foot pain. *Clin Radiol* 1992;46:261-4.
62. Mosel LD, Kat E, Voyvodic F. Imaging of the symptomatic type II accessory navicular bone. *Australas Radiol* 2004;48:267-71.
63. 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 J Nucl Med* 2014;29:191-2.
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* 2018;25:513-20.
65. Choi CH, Ogilvie-Harris DJ. Occult osteochondral fractures of the subtalar joint: a review of 10 patients. *J Foot Ankle Surg* 2002;41:40-3.
66. Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. *AJR Am J Roentgenol* 2004;183:615-22.
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. *Eur Radiol* 2018;28:4182-94.

68. 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. *Eur Radiol* 2003;13 Suppl 4:L164-77.
69. Karasick D, Schweitzer ME. The os trigonum syndrome: imaging features. *AJR Am J Roentgenol* 1996;166:125-9.
70. 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* 2015;9:TC10-3.
71. 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. *Am J Sports Med* 2016;44:1317-23.
72. 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* 2012;81:2771-5.
73. Porter DA. Fifth Metatarsal Jones Fractures in the Athlete. *Foot Ankle Int* 2018;39:250-58.
74. Tafur M, Rosenberg ZS, Bencardino JT. MR Imaging of the Midfoot Including Chopart and Lisfranc Joint Complexes. *Magn Reson Imaging Clin N Am* 2017;25:95-125.
75. Berman Z, Tafur M, Ahmed SS, Huang BK, Chang EY. Ankle impingement syndromes: an imaging review. *Br J Radiol* 2017;90:20160735.
76. Wang CL, Shieh JY, Wang TG, Hsieh FJ. Sonographic detection of occult fractures in the foot and ankle. *J Clin Ultrasound* 1999;27:421-5.
77. Oh SJ, Kim YH, Kim SK, Kim MW. Painful os peroneum syndrome presenting as lateral plantar foot pain. *Ann Rehabil Med* 2012;36:163-6.
78. Cochet H, Pele E, Amoretti N, Brunot S, Lafenetre O, Hauger O. Anterolateral ankle impingement: diagnostic performance of MDCT arthrography and sonography. *AJR Am J Roentgenol* 2010;194:1575-80.
79. McCarthy CL, Wilson DJ, Coltman TP. Anterolateral ankle impingement: findings and diagnostic accuracy with ultrasound imaging. *Skeletal Radiol* 2008;37:209-16.
80. 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* 2009;253:160-6.
81. 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* 2013;32:1643-52.
82. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed March 27, 2020.

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.