American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Chronic Foot Pain**

Variant 1: **Chronic foot pain of unknown etiology. First study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray foot	9	See the text for information on views.	☢
CT foot without IV contrast	1		☢
CT foot with IV contrast	1		☢
CT foot without and with IV contrast	1		☢
MRI foot without IV contrast	1		O
MRI foot without and with IV contrast	1		O
Tc-99m bone scan foot	1		☢☢☢
US foot	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: **Adult or child. Painful rigid flat foot. Radiographs unremarkable or equivocal and clinical concern for tarsal coalition.**

Radiologic Procedure	Rating	Comments	RRL*
CT foot without IV contrast	9	CT and MRI are alternative examinations. The RRL for the adult procedure is ☢.	☢☢
MRI foot without IV contrast	9	CT and MRI are alternative examinations.	O
Tc-99m bone scan foot	2		☢☢☢☢
US foot	2		O
MRI foot without and with IV contrast	1		O
CT foot with IV contrast	1	The RRL for the adult procedure is ☢.	☢☢
CT foot without and with IV contrast	1	The RRL for the adult procedure is ☢.	☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Chronic Foot Pain**

Variant 3: **Radiographs unremarkable or equivocal and clinical concern for complex regional pain syndrome type I.**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m 3-phase bone scan foot	8		☢☢☢
US foot	2		O
MRI foot without IV contrast	2		O
CT foot without IV contrast	2		☢
MRI foot without and with IV contrast	1		O
CT foot with IV contrast	1		☢
CT foot without and with IV contrast	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 4: **Adult or child. Radiographs noncontributory. Pain and tenderness over head of second metatarsal and clinical concern for Freiberg infraction.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray foot	9	Perform AP and lateral views, with or without oblique views.	☢
MRI foot without IV contrast	2		O
MRI foot without and with IV contrast	2		O
CT foot without IV contrast	2	The RRL for the adult procedure is ☢.	☢☢
CT foot with IV contrast	2	The RRL for the adult procedure is ☢.	☢☢
CT foot without and with IV contrast	2	The RRL for the adult procedure is ☢.	☢☢
Tc-99m bone scan foot	2		☢☢☢☢
US foot	2		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Chronic Foot Pain**

Variant 5: **Pain and tenderness over tarsus, unresponsive to conservative therapy. Radiographs showed accessory ossicle.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without IV contrast	9		O
Tc-99m bone scan foot	5	High-resolution techniques are preferred with this procedure.	☢☢☢
CT foot with IV contrast	3		☢
CT foot without and with IV contrast	3		☢
MRI foot without and with IV contrast	2		O
CT foot without IV contrast	2		☢
US foot	2		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 6: **Radiographs unremarkable, equivocal, or further diagnostic information needed. Clinical concern for inflammatory arthopathy, including rheumatoid arthritis.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without and with IV contrast	9		O
MRI foot without IV contrast	8		O
US foot	5	This procedure should be performed with power Doppler.	O
Tc-99m bone scan foot	1		☢☢☢
CT foot without and with IV contrast	1		☢
CT foot with IV contrast	1		☢
CT foot without IV contrast	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Chronic Foot Pain**

Variant 7: **Localized pain at the plantar aspect of the heel. Radiographs unremarkable or equivocal. Clinical concern for plantar fasciitis.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without IV contrast	9		O
US foot	6		O
CT foot without and with IV contrast	3		☢
MRI foot without and with IV contrast	2		O
Tc-99m bone scan foot	2		☢☢☢
CT foot without IV contrast	1		☢
CT foot with IV contrast	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 8: **Burning pain and paresthesias along the plantar surface of the foot and toes. Radiographs unremarkable or equivocal. Clinical concern for tarsal tunnel syndrome.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without IV contrast	9		O
MRI foot without and with IV contrast	7		O
US foot	5	There is limited data on this procedure.	O
CT foot without and with IV contrast	3		☢
Tc-99m bone scan foot	2		☢☢☢
CT foot without IV contrast	1		☢
CT foot with IV contrast	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 9: **Pain in the 3-4 web space with radiation to the toes. Radiographs unremarkable or equivocal. Clinical concern for Morton neuroma.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without and with IV contrast	9	MRI and US are alternative examinations.	O
US foot	9	MRI and US are alternative examinations.	O
MRI foot without IV contrast	7		O
CT foot without and with IV contrast	2		☢☢
CT foot with IV contrast	2		☢☢
Tc-99m bone scan foot	2		☢☢☢
CT foot without IV contrast	1		☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Chronic Foot Pain**

Variant 10: **Athlete with pain and tenderness over tarsal navicular. Radiographs unremarkable or equivocal. Clinical concern for stress injury or occult fracture.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without IV contrast	9		O
CT foot without IV contrast	6	This procedure is especially used for follow-up of healing fractures.	☢
MRI foot without and with IV contrast	2		O
Tc-99m bone scan foot	2	Perform this procedure if MRI cannot be performed.	☢☢☢
US foot	2		O
CT foot with IV contrast	1		☢
CT foot without and with IV contrast	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 11: **Radiographs unremarkable or equivocal and with persistent clinical concern for tendinopathy.**

Radiologic Procedure	Rating	Comments	RRL*
MRI foot without IV contrast	9		O
US foot	7		O
MRI foot without and with IV contrast	5		O
CT foot without and with IV contrast	3		☢
CT foot without IV contrast	1		☢
CT foot with IV contrast	1		☢
Tc-99m bone scan foot	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

CHRONIC FOOT PAIN

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Summary of Literature Review

Some of the conditions that cause chronic foot pain (>6 weeks in duration), as well as related imaging techniques, are reviewed in this document.

Tarsal Coalition

Tarsal coalition is a congenital abnormality resulting from fibrous, cartilaginous, or osseous union of 2 or more tarsal bones. Calcaneonavicular and middle-facet talocalcaneal coalitions are the most common. In about 20%–25% of patients the coalition is bilateral. Calcaneonavicular coalition is easily detected on oblique radiographs of the foot and confirmed by computed tomography (CT). Talocalcaneal (subtalar) coalition is often associated with valgus deformity of the hind foot, rigid painful flat foot, and restricted subtalar motion. It is frequently overlooked on standard foot radiographs because of overlapping structures; however, secondary signs on the lateral view could suggest a subtalar coalition. These signs include talar beaking, flattening and broadening of the lateral talar process, positive C-sign, ball-and-socket ankle joint, and narrowing of the posterior talocalcaneal joint [1]. A well-penetrated axial view (Harris-Beath view) can demonstrate the posterior and middle subtalar joints [2].

CT of the foot with acquisition or reconstructions perpendicular to the subtalar joint is usually diagnostic [3]. Also, the CT examination typically includes visualization of the other foot. Magnetic resonance imaging (MRI) has been shown to be effective in depicting all types of coalition [4]. Inversion-recovery MRI can reveal bone marrow edema along the margins of the abnormal articulation, which is an important clue to the diagnosis [5]. MRI provides a more sensitive and specific evaluation of the surrounding soft tissues than does CT in general.

Complex Regional Pain Syndrome Type I

Complex regional pain syndrome type I (CRPS I), is characterized clinically by pain, tenderness, swelling, diminished motor function, and vasomotor instability [6]. Associated conditions of the foot include fractures and other trauma, central nervous system (CNS) and spinal disorders, and peripheral nerve injury. CRPS I has also been described in children; the patients are predominantly girls [7]. Early diagnosis favorably affects outcome [6]. Diffuse osteopenia of the involved part is seen in 69% of patients who have CRPS I [8]. The osteopenia patterns are not pathognomonic and can be seen as a result of disuse. Three-phase radionuclide bone scans have been used to diagnose CRPS [8-11]. Holder et al [12] reported a characteristic delayed bone scan pattern consisting of diffuse increased tracer throughout the foot, with juxta-articular accentuation of tracer uptake. Overall sensitivity in this study was 100%, specificity 80%, positive predictive value 54%, and negative predictive value 100%. There are no specific findings on MRI in patients who have CRPS I [13]. Patients who have CRPS I of the lower extremity have increased power Doppler flow compared with asymptomatic control subjects [14].

Avascular Necrosis of the Metatarsal Head (Freiberg Disease)

This disease is characterized by pain, tenderness, swelling, and motion limitation in the affected metatarsophalangeal (MTP) joint [15]. The disease is usually detected in adolescents, and adolescent girls predominate 3–4:1. Radiographic changes are characteristic and show increased density of the metatarsal head

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and flattening, collapse, subchondral lucencies, and widening of the MTP joint. The second metatarsal is most commonly affected, although the third and fourth can also be involved [16].

Painful Accessory Bones

Potentially painful normal variants such as accessory navicular and os trigonum have been described [17-19]. Pain in the presence of an accessory navicular has been attributed to traumatic or degenerative changes at the synchondrosis or to soft-tissue inflammation. Symptomatic accessory navicular bones have been studied with radionuclide bone scans and MRI. Symptomatic lesions are reported to show increased radiotracer uptake or marrow edema across the synchondrosis [17,19].

For a painful os trigonum, selective arthrography of the synchondrosis followed by local anesthetic injection localizes the source of pain [17,19].

Arthritis

All the common forms of arthritis, including rheumatoid and seronegative arthritis, affect the feet and can cause chronic foot pain. Most arthritides are commonly evaluated with radiography [20]. There is evidence that gadolinium-enhanced MRI can help detect early rheumatoid arthritis [21,22] and seronegative arthritis [23,24]. MRI is also more sensitive than radiography in detecting erosive changes [25].

Ultrasound (US) can provide nearly the sensitivity and specificity of a contrast-enhanced MRI in the examination of the foot for synovitis and tenosynovitis but is more operator-dependent [26]. US evaluation can provide information in addition to clinical examination, which significantly impacts the initial diagnosis and treatment strategy in patients who have inflammatory arthropathy [27].

Chronic heel pain can be caused by calcaneal stress fractures, tarsal tunnel syndrome, and plantar fasciitis. When the heel pain is bilateral, the seronegative arthritides warrant consideration.

Plantar Fasciitis

Plantar fasciitis is the most common cause of plantar heel pain. It can occur in isolation or as a manifestation of a systemic disease such as the seronegative spondyloarthropathies, rheumatoid arthritis, gout, or systemic lupus erythematosus [28]. In athletes, plantar fasciitis is a common cause of foot pain and is attributed to mechanical stresses, presumably due to repetitive trauma, which causes plantar fascia microtearing at its origin as well as fascial and perifascial inflammation. Plantar fasciitis is also common in obese patients and in patients who have flat feet. Though radiography is typically insensitive to fasciitis, it should be the initial study. Bone scintigraphy and MRI have been shown to be help arrive at this diagnosis [29,30]. US has been shown by Cardinal et al [31] to be effective in differentiating the normal plantar fascia from tissue involved with plantar fasciitis.

Tarsal Tunnel Syndrome

This syndrome is a compressive neuropathy of the posterior tibial nerve or one of its branches. Patients typically complain of poorly localized burning pain and paresthesias along the plantar surface of the foot and toes [32]. Inflammatory processes or mass lesions in the tarsal tunnel are described as the cause for this syndrome in most affected patients. Such lesions are best imaged by MRI [33].

Interdigital (Morton) Neuroma

Morton neuroma is a non-neoplastic perineural fibrous proliferation involving a plantar digital nerve. Clinical symptoms include pain in the involved web space that often radiates to the toes. It is frequently asymptomatic [34]. Morton neuromas are seen more often in women and typically involve the 3–4 or, less commonly, 2–3 intermetatarsal space. They are best detected on MRI using T1-weighted or fat-suppressed T1-weighted images with gadolinium enhancement and T2-weighted images [35]. The diagnosis of Morton neuroma at MRI becomes relevant only when the transverse diameter of the lesion is $\geq$ 5 mm and can be correlated with the clinical findings [36]. High-resolution US has been used successfully to diagnose Morton neuromas [37]. US can approach the sensitivity of MRI in detecting Morton neuromas with appropriate operator expertise [38,39].

Stress Fractures

Stress fractures can also cause of chronic foot pain (see the ACR Appropriateness Criteria® topic on "Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae").

Tendinopathies

Tendinopathies, ranging from tendinosis to complete tears, in and around the foot can result in significant foot pain and disability. The most commonly affected tendons are the Achilles tendon, posterior tibial tendon, and peroneal tendons. Tendon dysfunction is best imaged with MRI and US [40,41].

Hallux Valgus

Hallux valgus is a common foot disorder resulting in significant morbidity. Preoperative evaluation and measurements and postoperative follow-up are best performed with weight-bearing posteroanterior and lateral radiographs of the feet [42-44].

Neoplasm

Neoplasm is another cause of chronic foot pain. Diagnostically, these foot lesions can be approached as are other neoplasms in the musculoskeletal system (see the ACR Appropriateness Criteria® topic on "Soft Tissue Masses" and the topic on "Primary Bone Tumors").

Osteomyelitis

Osteomyelitis can be a cause of chronic foot pain (see the ACR Appropriateness Criteria® topic on "Suspected Osteomyelitis in Patients with Diabetes Mellitus").

Summary

- Radiography is the foundation for imaging chronic foot pain. It is the initial study or the first step in the imaging algorithm for evaluating pedal pathology.
- CT is the secondary modality of choice to evaluate for tarsal coalition if radiographs are equivocal or unremarkable and clinical concern warrants further imaging evaluation.
- Tc-99m-labeled methylene diphosphonate bone scan is the modality of choice for evaluating CRPS after radiographs or if clinical concern warrants further imaging evaluation.
- MRI or US is complementary to radiography.
- In evaluating for inflammatory arthropathy, plantar fascitis, tarsal tunnel syndrome, interdigital (Morton) neuroma, and/or tendinopathy, MRI or US is indicated if the initial radiograph is equivocal or unremarkable and clinical concern warrants further imaging.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Documents

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

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