# American College of Radiology
# ACR Appropriateness Criteria®

**Clinical Condition:** **Chronic Foot Pain**

**Variant 1:** **20-year-old male suspected to have Reiter's disease. Now complains of heel pain and swollen toes.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray foot AP lateral and oblique | 9 | | Min |
| MRI foot | 2 | | None |
| CT foot | 2 | | Min |
| X-ray foot AP and lateral | 2 | | Min |
| NUC bone scan targeted | 2 | | Med |
| US foot | 2 | | None |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

**Variant 2:** **Pain and tenderness over the navicular tuberosity unresponsive to conservative therapy. Radiographs showed accessory navicular.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI foot | 9 | | None |
| NUC bone scan targeted | 3 | | Med |
| CT foot | 2 | | Min |
| US foot | 2 | | None |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

**Variant 3:** **Pain and tenderness over head of second metatarsal. Rule out Freiberg's disease.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray foot AP lateral with or without oblique | 9 | | Min |
| MRI foot | 2 | | None |
| CT foot | 2 | | Min |
| NUC bone scan targeted | 2 | | Med |
| US foot | 2 | | None |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

**Clinical Condition:** **Chronic Foot Pain**

**Variant 4:** **Athlete with pain and tenderness over tarsal navicular; radiographs are unremarkable.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI foot | 9 | | None |
| CT foot | 6 | Especially for follow-up of healing fractures. | Min |
| NUC bone scan targeted | 2 | If MRI cannot be performed. | Med |
| US foot | 2 | | None |
| **Rating Scale: 1=Least appropriate, 9=Most appropriate** | | | ***Relative Radiation Level** |

**Variant 5:** **To rule out reflex sympathetic dystrophy.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray foot AP lateral and oblique | 9 | | Min |
| NUC bone scan targeted | 8 | If radiographs are not diagnostic. | Med |
| US foot | 2 | | None |
| X-ray foot AP and lateral | 2 | | Min |
| MRI foot | 2 | | None |
| CT foot | 2 | | Min |
| **Rating Scale: 1=Least appropriate, 9=Most appropriate** | | | ***Relative Radiation Level** |

**Variant 6:** **Child or adolescent with painful rigid flat foot. Rule out tarsal coalition.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| CT foot | 9 | | Min |
| X-ray foot AP lateral and oblique and Harris-Beath view | 9 | | Min |
| NUC bone scan targeted | 2 | | Med |
| X-ray foot AP and lateral | 2 | | Min |
| US foot | 2 | | None |
| MRI foot | 2 | | None |
| **Rating Scale: 1=Least appropriate, 9=Most appropriate** | | | ***Relative Radiation Level** |

**Clinical Condition:** **Chronic Foot Pain**

**Variant 7:** **Middle aged woman with burning pain and paresthesias along the plantar surface of the foot and toes. Clinically, the patient is suspected of having tarsal tunnel syndrome.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray foot AP lateral and oblique | 9 | | Min |
| MRI foot | 9 | | None |
| US foot | 8 | Can be used in place of MRI, with the proper expertise. | None |
| CT foot | 2 | | Min |
| NUC bone scan targeted | 2 | | Med |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

**Variant 8:** **Patient is complaining of pain in the 3-4 web space with radiation to the toes. Morton's neuroma is clinically suspected.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI foot | 9 | | None |
| X-ray foot AP and lateral | 9 | | Min |
| US foot | 9 | Can be used in place of MRI, with the proper expertise. | None |
| CT foot | 2 | | Min |
| NUC bone scan targeted | 2 | | Med |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

**Variant 9:** **Young athlete presenting with localized pain at the plantar aspect of the heel. Plantar fasciitis is suspected clinically.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray foot AP and lateral | 9 | | Min |
| MRI foot | 9 | | None |
| US foot | 8 | Can be used in place of MRI, with the proper expertise. | None |
| CT foot | 2 | | Min |
| NUC bone scan targeted | 2 | | Med |
| **Rating Scale:** 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

# CHRONIC FOOT PAIN

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## Summary of Literature Review

Many conditions can affect the foot and cause chronic foot pain. Some of these conditions and techniques to image them are reviewed here.

### Tarsal Coalition

Tarsal coalition is a congenital abnormality resulting from fibrous, cartilaginous, or osseous union of two or more tarsal bones. Calcaneonavicular and middle-facet talocalcaneal coalitions are the most common. In about half the 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 severe 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 be suggestive of a subtalar coalition. These signs include talar beaking, flattening and broadening of the lateral talar process, positive C-sign, and narrowing of the posterior talocalcaneal joint [1]. A well-penetrated axial view (Harris-Beath view) can demonstrate the posterior and middle subtalar joints [2,3].

CT of the subtalar joint is usually diagnostic [3,4]. Magnetic resonance imaging (MRI) has been shown to be effective in depicting all types of coalition [5]. Inversion-recovery MR images may reveal bone marrow edema along the margins of the abnormal articulation, which is an important clue to the diagnosis [6].

### Reflex Sympathetic Dystrophy (RSD) Syndrome

Reflex sympathetic dystrophy (RSD), also called complex regional pain syndrome type I (CRPS I), is characterized clinically by pain, tenderness, swelling, diminished motor function, and vasomotor instability [7]. Conditions associated with RSD of the foot include fractures and other trauma, central nervous system (CNS) and spinal disorders, and peripheral nerve injury. RSD has also been described in children; the patients are predominantly girls [8]. Early diagnosis favorably affects outcome [7]. Diffuse osteopenia of the involved part is seen in 69% of patients with RSD [9]. The osteopenia patterns are not pathognomonic and can be seen as a result of disuse [10]. Three-phase radionuclide scans have been used to diagnose RSD [9,11,12]. Holder et al [13] reported 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 with RSD [14,15]. Using power Doppler sonography, patients with RSD of the lower extremity have increased power Doppler flow compared with asymptomatic control subjects [16].

### Stress Fractures

[Also see the ACR Appropriateness Criteria® on *Stress/Insufficiency Fracture, Including Sacrum, Excluding Other Vertebrae*]. Stress injuries can be categorized into three types: stress reactions, fatigue fractures, and insufficiency fractures. A stress reaction occurs when microfractures are healing and a complete fracture has not yet developed [17]. Activities producing fatigue fractures in the feet include running, marching, and dancing. The second and third metatarsals as well as the calcaneus are the most common sites for stress fractures and stress reactions [18-20].

Stress fractures have also been described, less frequently, in the tarsal navicular, first metatarsal, and medial sesamoid bones of the great toe. In the early phase, radiography may be entirely normal, but with time a fracture line can be identified and only one cortex may be involved; a hint of periosteal reaction with some endosteal new bone may develop. It may take 3-4 weeks for changes to occur in the metaphyseal area of bone and 4-6 weeks for them to occur in the diaphysis [15-19]. During the healing phase, both periosteal and endosteal new bone are incorporated in the cortex, resulting in a fusiform expansion of the cortex. Occasionally more than one stress fracture is present in the same foot [21]. Most of the navicular fractures are oriented in the sagittal plane and occur in the central third of the bone. Some are

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partial fractures involving only the dorsal portion of the navicular [22,23]. Participation in strenuous exercise is not essential for such fractures to develop [24].

Initially radiographs can be negative, and the panel believes that the best next test is MRI.

**Avascular Necrosis of the Metatarsal Head (Freiberg's Disease)**

This disease is characterized by pain, tenderness, swelling, and limitation of motion in the affected metatarsophalangeal (MP) joint [25]. The disease is usually detected in adolescents, and adolescent girls predominate about three or four to one. Radiographic changes are characteristic, and they show increased density of the metatarsal head, and flattening, collapse, cystic changes, and widening of the MP joint. The second metatarsal is most commonly affected, although the third and fourth can also be occasionally involved [26].

**Painful Accessory Bones**

Potentially painful normal variants such as accessory navicular and os trigonum have been described [27-29].

The mechanism of 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 [30,31].

For a painful os trigonum, selective arthrography of the synchondrosis followed by local anesthetic injection localizes the source of pain [32,33].

**Neoplasm**

Neoplasm is another cause of chronic foot pain, and (diagnostically) these lesions in the foot can be approached like other neoplasms in the musculoskeletal system (see the ACR Appropriateness Criteria® on *Soft Tissue Masses* and the ACR Appropriateness Criteria® on *Bone Tumors*).

**Arthritis**

All the common forms of arthritis affect the feet and can cause chronic foot pain. Most of the arthritides are best evaluated with radiography [34]. Charcot changes are still best detected and followed by radiography also [35]. There is now evidence that gadolinium-enhanced MRI can be helpful in detecting early rheumatoid arthritis [36,37].

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 may occur in isolation or as a manifestation of a systemic disease such as the seronegative spondyloarthropathies, rheumatoid arthritis, gout, or systemic lupus erythematosus (SLE) [27]. In athletes, plantar fasciitis is a common cause of foot pain and it is attributed to mechanical stresses, presumably due to repetitive trauma causing microtearing of the plantar fascia at its origin as well as fascial and perifascial inflammation. Plantar fasciitis is also common in obese patients and in patients with flat feet. Typically radiography is not productive, but bone scintigraphy and MRI have been shown to be helpful in arriving at a diagnosis [27-29,38,39]. Ultrasonography has been shown by Cardinal et al [40] to be effective in differentiating normal plantar fascia from those 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 [41,42]. Inflammatory processes or mass lesions in the tarsal tunnel are described as the cause for this syndrome in most of patients with this syndrome. Such lesions are best imaged by MRI [41-43].

**Interdigital (Morton's) Neuroma**

This is a nonneoplastic perineural fibrous proliferation involving a plantar digital nerve. Clinical symptoms include pain in the involved web space that often radiates to the toes. Morton's neuroma is frequently asymptomatic [44]. These neuromas are seen more often in women and typically involve the three-four or less commonly the two-three intermetatarsal space. They are best detected on MRI using T1-weighted or T1-weighted, fat-suppressed images with gadolinium enhancement and T2-weighted images [45-46]. The diagnosis of Morton's neuroma at MRI becomes relevant only when transverse diameter of the lesion is 5 mm or more and can be correlated with the clinical findings [47,48]. High-resolution ultrasound has been used successfully to diagnose Morton's neuromas [49].

**Tendinopathies**

Tendinopathies, ranging from tendinosis to complete tear, in and around the foot can result in significant foot pain and disabilities. The most commonly affected tendons are the Achilles tendon, posterior tibial tendon, and peroneal tendons. Tendon dysfunction is best imaged with MRI and ultrasound [50-55].

**Hallux Valgus**

Hallux valgus is a common foot disorder resulting in significant morbidity. Preoperative radiographic

evaluation and measurements as well as postoperative follow-up are best evaluated on the weight-bearing PA and lateral radiographs of the feet [56-58].

### 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. 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** | **Effective Dose Estimate Range** |
| None | 0 |
| Minimal | < 0.1 mSv |
| Low | 0.1-1 mSv |
| Medium | 1-10 mSv |
| High | 10-100 mSv |

## References


1. Lateur LM, Van Hoe LR, Van Ghillewe KV, et al. Subtalar coalition: diagnosis with the C sign on lateral radiographs of the ankle. *Radiology* 1994; 193(3):847-851.
2. Harris RL, Beath T. Etiology of peroneal spastic flat foot. *J Bone Joint Surg* 1948; 30(B):624-634.
3. Lee MS, Harcke HT, Kumar SJ, Bassett GS. Subtalar joint coalition in children: new observations. *Radiology* 1989; 172(3):635-639.
4. Wechsler RJ, Karasick D, Schweitzer ME. Computed tomography of talocalcaneal coalition: imaging techniques. *Skeletal Radiol* 1992; 21(6):353-358.
5. Wechsler RJ, Schweitzer ME, Deely DM, et al. Tarsal coalition: depiction and characterization with CT and MR imaging. *Radiology* 1994; 193(2):447-452.
6. Newman JS, Newberg AH. Congenital tarsal coalition: multimodality evaluation with emphasis on CT and MR imaging. *Radiographics* 2000; 20(2):321-332.
7. Poplawski ZJ, Wiley AM, Murray JF. Post-traumatic dystrophy of the extremities. *J Bone Joint Surg* Am 1983; 65(5):642-655.
8. Wilder RT, Berde CB, Wolohan M, et al. Reflex sympathetic dystrophy in children. Clinical characteristics and follow-up of seventy patients. *J Bone Joint Surg* Am 1992; 74(6):910-919.
9. Kozin F, Soin JS, Ryan LM, et al. Bone scintigraphy in the reflex sympathetic dystrophy syndrome. *Radiology* 1981; 138(2):437-443.
10. Kozin F. Reflex sympathetic dystrophy syndrome. *Bull Rheum Dis* 1986; 36(3):1-8.
11. Genant HK, Kozin F, Bekerman C, et al. The reflex sympathetic dystrophy syndrome. A comprehensive analysis using fine-detail radiography, photon absorptiometry, and bone and joint scintigraphy. *Radiology* 1975; 117(1):21-32.
12. Simon H, Carlson DH. The use of bone scanning in the diagnosis of reflex sympathetic dystrophy. *Clin Nucl Med* 1980; 5(3): 116-121.
13. Holder LE, Cole LA, Myerson MS. Reflex sympathetic dystrophy in the foot: clinical and scintigraphic criteria. *Radiology* 1992; 184(2):531-535.
14. Schweitzer ME, Mandel S, Schwartzman RJ, et al. Reflex sympathetic dystrophy revisited: MR imaging findings before and after infusion of contrast material. *Radiology* 1995; 195(1):211-214.
15. Koch E, Hofer HO, Sialer G, et al. Failure of MR imaging to detect reflex sympathetic dystrophy of the extremities. *AJR* 1991; 156(1):113-115.
16. 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.
17. Eisele SA, Sammarco GJ. Fatigue fractures of the foot and ankle in the athlete. *J Bone Joint Surg* Am 1993; 75(2):290-298.
18. Schneider HJ, King AY, Bronson JL, Miller EH. Stress injuries and developmental change of lower extremities in ballet dancers. *Radiology* 1974; 113(3):627-632.
19. Levy JM. Stress fractures of the first metatarsal. *AJR* 1978; 130(4):679-681.
20. Greaney RB, Gerber FH, Laughlin RL, et al. Distribution and natural history of stress fractures in U.S. marine recruits. *Radiology* 1983; 146(2):339-346.
21. Meurman KO, Elfving S. Stress fracture in soldiers: a multifocal bone disorder. A comparative radiological and scintigraphic study. *Radiology* 1980; 134(2):483-487.
22. Kiss ZS, Khan KM, Fuller PJ. Stress fractures of the tarsal navicular bone: CT findings in 55 cases. *AJR* 1993; 160(1):111-115.
23. Torg JS, Pavlov H, Cooley LH, et al. Stress fractures of the tarsal navicular. A retrospective review of twenty-one cases. *J Bone Joint Surg* Am 1982; 64(5):700-712.
24. Nussbaum AR, Treves ST, Micheli L. Bone stress lesions in ballet dancers: scintigraphic assessment. *AJR* 1988; 150(4):851-855.
25. Gauthier G, Elbaz R. Freiberg's infraction: a subchondral bone fatigue fracture. A new surgical treatment. *Clin Orthop* 1979; (142):93-95.
26. Nguyen VD, Keh RA, Dachler RW. Freiberg's disease in diabetes mellitus. *Skeletal Radiol* 1991; 20(6):425-428.
27. Furey JG. Plantar fasciitis. The painful heel syndrome. *J Bone Joint Surg* 1975; 57(5):672-673.
28. Graham CE. Painful heel syndrome: rationale of diagnosis and treatment. *Foot Ankle* 1983; 3(5):261-267.
29. Berkowitz JF, Kier R, Rudicel S. Plantar fasciitis: MR imaging. *Radiology* 1991; 179(3):665-667.
30. Lawson JP, Ogden JA, Sella E, Barwick KW. The painful accessory navicular. *Skeletal Radiol* 1984; 12(4):250-262.
31. Miller TT, Staron RB, Feldman F, et al. The symptomatic accessory tarsal navicular bone: assessment with MR imaging. *Radiology* 1995; 195(3):849-853.
32. Romanowski CA, Barrington NA. The accessory navicular-an important cause of medial foot pain. *Clin Radiol* 1992; 46(4): 261-264.
33. Karasick D, Schweitzer ME. The os trigonum syndrome: imaging features. *AJR* 1996; 166(1):125-129.
34. Sharp JT. Scoring radiographic abnormalities in rheumatoid arthritis. *Radiol Clin North Am* 1996; 34(2):233-241.
35. Johnson JT. Neuropathic fractures and joint injuries. Pathogenesis and rationale of prevention and treatment. *J Bone Joint Surg* Am 1967; 49(1):1-30.
36. Ostendorf B, Scherer A, Modder U, Schneider M. Diagnostic value of magnetic resonance imaging of the forefeet in early rheumatoid arthritis when findings on imaging of the metacarpophalangeal joints of the hands remain normal. *Arthritis Rheum* 2004; 50(7):2094-2102.
37. Boutry N, Larde A, Lapegue F, et al. Magnetic resonance imaging appearance of the hands and feet in patients with early rheumatoid arthritis. *J Rheumatol* 2003; 30(4):671-690.

38. Grasel RP, Schweitzer ME, Kovalovich AM, et al. MR imaging of plantar fasciitis: edema, tears, and occult marrow abnormalities correlated with outcome. *AJR* 1999; 173(3):699-701.
39. Theodorou DJ, Theodorou SJ, Kakitsubata Y, et al. Plantar fasciitis and fascial rupture: MR imaging findings in 26 patients supplemented with anatomic data in cadavers. *Radiographics* 2000; 20 Spec No:S181-S197.
40. Cardinal E, Chhem RK, Beauregard CG, et al. Plantar fasciitis: sonographic evaluation. *Radiology* 1996; 201(1):257-259.
41. Kerr R, Frey C. MR imaging in tarsal tunnel syndrome. *J Comput Assist Tomogr* 1991; 15(2):280-286.
42. Frey C, Kerr R. Magnetic resonance imaging and the evaluation of tarsal tunnel syndrome. *Foot Ankle* 1993; 14(3):159-164.
43. Erickson SJ, Quinn SF, Kneeland JB, et al. MR imaging of the tarsal tunnel and related spaces: normal and abnormal findings with anatomic correlation. *AJR* 1990; 155(2):323-328.
44. Bencardino J, Rosenberg ZS, Beltran J, et al. Morton's neuroma: is it always symptomatic? *AJR* 2000; 175(3):649-653.
45. Erickson SJ, Canale PB, Carrera GF, et al. Interdigital (Morton) neuroma: high-resolution MR imaging with a solenoid coil. *Radiology* 1991; 181(3):833-836.
46. Terk MR, Kwong PK, Suthar M, et al. Morton neuroma: evaluation with MR imaging performed with contrast enhancement and fat suppression. *Radiology* 1993; 189(1):239-241.
47. Zanetti M, Ledermann T, Zollinger H, Hodler J. Efficacy of MR imaging in patients suspected of having Morton's neuroma. *AJR* 1997; 168(2):529-532.
48. 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.
49. Redd RA, Peters VJ, Emery SF, et al. Morton neuroma: sonographic evaluation. *Radiology* 1989; 171(2): 415-417.
50. Quinn SF, Murray WT, Clark RA, Cochran CF. Achilles tendon: MR imaging at 1.5T. *Radiology* 1987; 164(3):767-770.
51. Khoury NJ, El-Khoury GY, Saltzman CL, Brandser EA. MR imaging of posterior tibial tendon dysfunction. *AJR* 1996; 167(3):675-682.
52. Khoury NJ, El-Khoury GY, Saltzman CL, Kathol MH. Peroneus longus and brevis tendon tears: MR imaging evaluation. *Radiology* 1996; 200(3):833-841.
53. Fornage BD. Achilles tendon: US examination. *Radiology* 1986; 159(3):759-764.
54. Narvaez JA, Narvaez J, Ortega R, et al. Painful heel: MR imaging findings. *Radiographics* 2000; 20(2):333-352.
55. Blankstein A, Cohen I, Diamant L, et al. Achilles tendon pain and related pathologies: diagnosis by ultrasonography. *Isr Med Assoc J* 2001; 3(8):575-578.
56. Smith RW, Reynolds JC, Stewart MJ. Hallux valgus assessment: report of research committee of American Orthopaedic Foot and Ankle Society. *Foot Ankle* 1984; 5(2):92-99.
57. Karasick D, Wapner KL. Hallux valgus deformity: preoperative radiologic assessment. *AJR* 1990; 155(1):119-123.
58. Kuwano T, Nagamine R, Sakaki K, et al. New radiographic analysis of sesamoid rotation in hallux valgus: comparison with conventional evaluation methods. *Foot Ankle Int* 2002; 23(9):811-817.