Provider Led Entity

CDI Quality Institute PLE
Ankle and/or Hind Foot Pain AUC

Appropriateness of advanced imaging procedures* in patients with ankle and/or hind foot** pain:

11/19/2019

*Including MRI, MR arthrography, CT, CT arthrography, Nuclear medicine w/ or w/o SPECT, or PET

**Hind foot refers to structures posterior to the tarsometatarsal joints

Abbreviation list:

ACOEM	American College of Occupational & Environmental Medicine
AAOS	American Academy of Orthopaedic Surgeons
ACR	American College of Radiology
AVN	Avascular necrosis
AUC	Appropriate Use Criteria
CT	Computed tomography
CTA	Computed tomographic arthrography
DM	Diabetes mellitus
EULAR	European League Against Rheumatism
In-111 WBC	Indium 111-labeled white blood cell
IWGDF	International Working Group on the Diabetic Foot
LAS	Lateral ankle sprain
MRA	Magnetic resonance arthrography
MRI	Magnetic resonance imaging
NICE	National Institute for Health and Care Excellence
OA	Osteoarthritis
OAR	Ottawa ankle rules
OCD	Osteochondral defect
ON	Osteonecrosis
PET	Positron emission tomography
PLE	Provider Led Entity
SPECT	Single-photon emission computerized tomography
SVS	Society for Vascular Surgery
TC-99m	Technetium-99m
TTS	Tarsal tunnel syndrome
US	Ultrasound

Ankle and/or hind foot pain and/or instability after an acute injury* with suspected structural derangement** and no fracture on radiographs

- **Green** – ‡
- **Yellow** – MRI without IV contrast in patients with suspected or present red flags‡‡
- **Yellow** – CT without IV contrast in patients with suspected or present red flags‡‡ who cannot undergo MRI
- **Yellow** – MRI without IV contrast in patients with significant pain and/or disability and/or for surgical planning
- **Yellow** – CT without IV contrast in patients who cannot undergo MRI with significant pain and/or disability and/or for surgical planning
- **Red** – MRI without and with IV contrast, MRI with IV contrast, CT with IV contrast, CT without and with IV contrast, planar bone scan, bone scan/SPECT, bone scan/SPECT/CT***, PET, PET/CT, MR arthrography, CT arthrography

* Acute injury is defined as a discrete event resulting in excessive force on the ankle/hind foot, in contradistinction to overuse injuries that result from chronic repetitive injuries or insufficiency injuries that result from normal forces on structurally deficient bone.

** Signs and symptoms of structural derangement after an injury can include instability, locking, catching, effusion, inability to bear weight, bone tenderness, loss of motion, and/or pathological laxity.

‡ For most cases presenting with true foot and ankle disorders, special studies are usually not needed until after a period of conservative care and observation. Most ankle and foot problems improve quickly in patients without red flags (Hegmann et al [*ACOEM*] 2018).

‡‡ Red flags [aside from fracture] include dislocation, neurologic compromise, vascular compromise, tendon rupture, or neoplastic, metabolic, inflammatory or infection disorders (Hegmann et al [*ACOEM*] 2018). The expert panel also concluded that clinical suspicion of osteochondral injury, high-grade ligament injuries, or syndesmotic (high ankle sprain) injuries also represent red flags (PLE expert committee consensus statement).

Level of Evidence: MRI without contrast: moderate; CT without contrast: low; bone scan; MRI without and with contrast, MRI with contrast, MR arthrography, CT arthrography, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
***Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
[For acute ankle and foot injury and positive findings on the OAR] MRI or CT is appropriate in the presence of significant pain and disability and negative radiographs (Bussieres et al 2007 pg 11).

If radiograph appears normal with clearly abnormal clinical examination, MRI…may be indicated depending on pain, severity, and disability (Bussieres et al 2007 pg 11).

Ankle
There is no recommendation for or against the use of MRI or CT for the assessment of acute ankle sprain

(Hegmann et al [*ACOEM*] 2018, strength of evidence: no recommendation, insufficient evidence / level of confidence: low pg. 207-208).

MRA is not recommended for the assessment of acute ankle sprain (Hegmann et al [*ACOEM*] 2018, strength of evidence: not recommended, insufficient evidence / level of confidence: low pg. 207).

In case of suspicion of high-grade ligament injuries, osteochondral defects, syndesmotic injuries and occult fractures, an MRI can be performed because of its excellent sensitivity and specificity for visualizing these injuries (Vuurberg et al. 2018 pg 6).

Bone scans are recommended for select patients with acute ankle sprain and indication of suspected stress fracture [see stress fracture scenario on page 14 of this document] (Hegmann et al [ACOEM] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: low pg 208).

Hind foot

[Although ultrasound is generally preferred,] MRI is recommended for the evaluation of acute Achilles tendon rupture, particularly where there is diagnostic uncertainty (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: moderate pg 56).

The *American Academy of Orthopaedic Surgeons* (*AAOS*) was unable to recommend for or against the routine use of MRI, ultrasound, and radiograph to confirm the diagnosis of acute Achilles tendon rupture (Chiodo et al [*AAOS*] 2010, strength of recommendation: inclusive pg 36).

In patients with *acute injury to the foot, physical examination is concerning for an acute tendinous rupture or dislocation in the foot, radiographs negative*, the *American College of Radiology* (*ACR*) recommends MRI [ankle/Achilles/hindfoot**] without IV contrast (9), CT [ankle/Achilles/hindfoot**] without IV contrast (5) or ultrasound (5) (Bancroft et al [*ACR*] 2015* variant 7). **This recommendation is used in reference to the diagnosis of acute ruptures of the Achilles, posterior tibialis or peroneal tendons.

Occult Fracture

In case of suspicion of…occult fractures, an MRI can be performed because of its excellent sensitivity and specificity for visualizing these injuries (Vuurberg et al. 2018 pg 6).

CT should be considered when x-ray images are negative, but on the basis of physical findings, an occult fracture is strongly suspected (Hegmann et al [*ACOEM*] 2018 strength of evidence: recommended, insufficient evidence/ level of confidence: moderate pg 348).

* This guideline did not pass the AGREE II cutoff of 90. It was included, however, because of its direct relevance to the acute hind foot injury scenario.

Clinical notes:

- For most cases presenting with true foot and ankle disorders, special studies are usually not needed until after a period of conservative care and observation. Most ankle and foot problems improve quickly once any red flags (fracture, dislocation, neurovascular compromise, tendon rupture, or neoplastic, metabolic, inflammatory or infection disorders) are ruled out (Hegmann et al [*ACOEM*] 2018).

Ankle

- In case of a severe ankle sprain, a fracture should be excluded by proper use of the Ottawa ankle rules (OAR), and if indicated, conventional radiographic imaging should be undertaken (Vuurberg et al 2018).
- Poor availability of MRI in combination with the high prevalence of ankle sprains limits the use of MRI in acute settings, but in case of persisting symptoms it may be useful to diagnose underlying joint damage (Vuurberg et al 2018).
- Ultrasound is not recommended for evaluation of select patients with acute ankle sprain, as findings in the acute setting are unlikely to alter management (Hegmann et al [*ACOEM*] 2018).
- Arthrography is an invasive procedure and its sensitivity and specificity are equal to delayed physical examination; it is not recommended as a diagnostic tool for ankle sprains in the acute setting (Vuurberg et al 2018).

Hind foot

- Ultrasound is recommended as the main confirmatory diagnostic test for Achilles ruptures, particularly when there is diagnostic uncertainty (Hegmann et al [*ACOEM*] 2018).
- MRI tends to be used as a screening tool when one is not certain of the specific tendon injury or if concomitant osseous injury is suspected (Bancroft et al [*ACR*] 2015).
- CT imaging has been shown to be quick and effective in documenting peroneal tendon dislocations (Bancroft et al [*ACR*] 2015).

<u>Evidence update (2015 – Present):</u>

Chun et al (2019) conducted a systematic review and meta-analysis to determine whether radiologic tests accurately and reliably diagnose ankle syndesmosis injury. A total of 8 studies were included for qualitative synthesis, and 6 used for meta-analysis. Pooled sensitivity and specificity were 0.528 and 0.984 for X-rays, 0.669 and 0.87 for CT, and 0.929 and 0.865 for MRI, respectively. Syndesmosis injuries differed significantly in the accuracy of radiological methods according to the presence of accompanied ankle fractures. In patients with fractures, simple radiography has good specificity, and CT and MRI have high sensitivity and specificity irrespective of fracture; in particular, MRI has similar accuracy to gold standard arthroscopic findings (low level of evidence).

Krahenbuhl et al (2018) conducted a systematic literature review of current diagnostic imaging options for assessing distal tibio-fibular syndesmosis. Included studies used conventional radiographs / fluoroscopy, CT, or MRI. Forty-two articles were included and subdivided into three groups: studies using conventional radiographs (22 articles), studies using CT (15 articles), and studies using MRI (9 articles). Overall, the included studies showed low probability of bias and were deemed applicable in daily practice. Results found that conventional radiographs cannot predict syndesmotic injuries reliably, and CT scans outperform plain radiographs in detecting syndesmotic malreduction. Additionally, the syndesmotic interval can be assessed in greater detail by CT. MRI measurements achieve a sensitivity and specificity of nearly 100%; however, correlating MRI findings with patients' complaints is difficult, and utility with subtle syndesmotic instability needs further investigation (moderate level of evidence).

Ohashi et al (2015) tested the diagnostic accuracy of 3D color volume-rendered (VR) CT images of the ankle for peroneal tendon dislocation in 105 patients with acute calcaneal fractures. 121 ankle CT studies from 105 consecutive patients were included. Peroneal tendon dislocation was diagnosed on multiplanar CT images by consensus of two experienced musculoskeletal radiologists and served as the

reference standard. Three other musculoskeletal radiologists independently reviewed 3D images. 48 (40%) out of 121 studies showed peroneal tendon dislocation based on expert readings using multiplanar reformatted (MPR) images. Sensitivities/specificities of 3D images measured 0.92/0.81, 0.88/0.90, and 0.81/0.92 for the three readers, respectively. The area under the proper binormal ROC curve based on all three readers (0.93, 0.94, and 0.92) measured 0.93 with a 95% confidence interval of 0.89–0.98. The authors conclude that diagnostic accuracy of 3D images is comparable to, but not as good as that of MPR images for the diagnosis of peroneal tendon dislocation in patients with acute calcaneal fractures (low level of evidence).

Ankle and/or hind foot pain in the setting of acute* injury with suspected or known fracture(s) **:

- **Green** - ‡
- **Yellow** – MRI without IV contrast or CT without IV contrast with suspicion of an radiographically occult fracture
- **Yellow** – MRI without IV contrast or CT without IV contrast for suspected or known hind foot fracture
- **Yellow** – MRI without IV contrast or CT without IV contrast for surgical planning
- **Red** – MRI without and with IV contrast, MRI with IV contrast, CT without and with IV contrast, CT with IV contrast, MR arthrography, CT arthrography, planar bone scan, bone scan/SPECT, bone scan/SPECT/CT***, PET, PET/CT

*An injury occurring within the past 4 weeks is considered an acute injury (PLE expert panel consensus opinion).

**Osteochondral fractures or defects are addressed in a separate AUC scenario on page 18 of this document.

‡ The Ottawa ankle and foot rules (OAR) should be used to determine whether radiographs are needed for suspected ankle fractures within one week after initial trauma (*NICE* 2016; Vuurberg et al 2018). Radiographs, while not considered to be advanced imaging, are recommended as the first-line imaging study for suspected fractures (*ACOEM* 2018; *NICE* 2016; Vuurberg et al 2018).

Level of Evidence: MRI without contrast, CT without contrast: moderate; bone scan; SPECT; MRI without and with contrast, MRI with contrast, MR arthrography, CT arthrography, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
***Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
MRI is the preferred imaging modality for evaluation of soft tissue injuries associated with fractures and to detect occult fractures (PLE expert panel consensus opinion).

MRI is recommended for investigation of distal lower extremity and ankle fractures in certain circumstances. Upon confirmation of a displaced, comminuted, or unstable fracture, MRI may be an important diagnostic technique for the evaluation of suspected injuries of soft tissues related to distal fibular, tibial, and malleolar fractures, such as to the syndesmotic ankle ligament complex, extensor tendons, deltoid ligament, or tibial nerve (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence / level of confidence: moderate pg 312).

In case of suspicion of…occult fractures, an MRI can be performed because of its excellent sensitivity and specificity for visualizing these injuries (Vuurberg et al. 2018 pg 6).

CT should be considered when x-ray images are negative, but on the basis of physical findings, an occult fracture is strongly suspected (Hegmann et al [*ACOEM*] 2018 strength of evidence: recommended, insufficient evidence/ level of confidence: moderate pg 348).

CT is the preferred imaging modality for evaluation of bony anatomy and is the gold standard for

assessing ankle or hind foot fractures (PLE expert panel consensus opinion).

CT is recommended for investigation of distal lower extremity and ankle fractures in certain circumstances. CT may be useful for evaluation of complex comminuted fractures providing superior depiction of distal tibial articular surface involvement, fragment positioning, and diagnosis of subluxations (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence / level of confidence: moderate pg 312-313).

CT is recommended for investigation of hindfoot fractures; indications – occult and complex distal extremity, ankle, and foot fractures to gain greater clarity of fracture displacement, articular involvement, and subluxation of affected joints. CT is recommended for the evaluation of suspected subtalar joint fractures. CT is the gold standard and should be used to diagnosis and classify calcaneus fractures (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, evidence (C) / level of confidence: high pg 348).

Clinical/imaging notes:

- The Ottawa ankle and foot rules (OAR), an accurate and valid tool, should be used to determine whether radiographs are needed for suspected ankle fractures within one week after initial trauma (*NICE* 2016; Vuurberg et al 2018).
    - Only 15% of patients with a lateral ankle sprain (LAS), who are examined using radiographs, are diagnosed with an ankle fracture (Vuurberg et al 2018).
    - Ankle radiographs are indicated in patients with acute ankle or foot injury and positive findings on the OAR (Bussieres et al 2007; *ACOEM* 2015; Vuurberg et al 2018).
- Radiographs are recommended as a first-line study for suspected hindfoot fractures (Hegmann et al [*ACOEM*] 2018).

Evidence update (January 2015 - present):
Chun et al (2019) conducted a systematic review and meta-analysis to determine whether radiologic tests accurately and reliably diagnose ankle syndesmosis injury. A total of 8 studies were included for qualitative synthesis, and 6 used for meta-analysis. Pooled sensitivity and specificity were 0.528 and 0.984 for X-rays, 0.669 and 0.87 for CT, and 0.929 and 0.865 for MRI, respectively. Syndesmosis injuries differed significantly in the accuracy of radiological methods according to the presence of accompanied ankle fractures. In patients with fractures, simple radiography has good specificity, and CT and MRI have high sensitivity and specificity irrespective of fracture; in particular, MRI has similar accuracy to gold standard arthroscopic findings (low level of evidence).

Park et al (2018) assessed the use of preoperative MRI for syndesmotic instability in 74 patients with unstable ankle fracture (Lauge-Hansen supination external rotation/Weber B type or pronation external rotation/Weber C type). MRI findings of the syndesmotic ligament and results of an intraoperative stress test were evaluated. Twenty-six patients had a positive result on the intraoperative stress test for syndesmotic instability. MRI findings of syndesmotic ligaments revealed that complete tear of the posterior inferior tibiofibular ligament (PITFL) was the most reliable predictor of syndesmotic instability (sensitivity, 74%; specificity, 78%; PPV, 54%). Interobserver agreement for intraoperative stress test and MRI assessment was excellent, except for MRI findings of the interosseous ligament (62% agreement; kappa, 0.3). The authors conclude that complete tear of the PITFL on MRI has additional diagnostic value for syndesmotic instability in ankle fracture (low level of evidence).

Leung et al (2016) reviewed preoperative radiography and CT in 69 patients with ankle fracture to

determine the value of CT for diagnosis and surgical planning. CT was deemed necessary when radiographs showed (1) comminuted fracture of the medial malleolus involving the tibial plafond, (2) comminuted fracture of the posterior malleolus, (3) presence of loose bodies, and/or (4) suspected Chaput or Volkman fracture fragment. Two orthopaedic surgeons independently reviewed the radiographs to look for CT-indicated features. Based on radiographs, 19 (28%) patients had features of posterior malleolar comminution (n=7), medial malleolar comminution (n=7), suspected Chaput fracture fragment (n=1), suspected Volkman fracture fragment (n=1), and combination of 2 lesions (n=3), and were deemed to require CT. In 10 (20%) of the remaining 50 patients, the surgical plan was modified after CT scan review. The intra- and inter-observer agreement was good to excellent. The authors conclude that radiography alone is not adequate for surgical planning for ankle fractures, and more accurate imaging tools such as CT are necessary for diagnosis (low level of evidence).

Nontraumatic (chronic) ankle and/or hind foot pain persisting after an appropriate trial of conservative care (≥ 4 weeks) and no major abnormalities (e.g., fracture, AVN, coalition, or moderate to severe osteoarthritis) on radiographs:

- **Green** – MRI without IV contrast
- **Yellow** – CT without IV contrast in patients unable to undergo MRI
- **Yellow** – MR arthrography or CT arthrography to assess chronic instability, cartilage injury, identification of intraarticular bodies, or suspected impingement syndrome
- **Yellow** – Planar bone scan or bone scan/SPECT or bone scan/SPECT/CT* in patients with equivocal MRI findings, or for patients unable to undergo MRI
- **Red** – MRI with IV contrast, MRI without and with IV contrast, CT with IV contrast, CT without and with IV contrast, PET, PET/CT

Level of Evidence: MRI without contrast: moderate-high; MR arthrography: moderate; CT without contrast, CT arthrography: low; SPECT/CT with bone scan: very low; MRI without and with contrast, MRI with contrast, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
*Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
[For chronic ankle or tarsal pain] MRI is the gold standard for musculoskeletal assessment if radiography is positive or if pain is unrelieved by 4 weeks of conservative care (Bussieres et al 2007 [D] pg 11).

[For chronic ankle or tarsal pain] If radiograph appears normal with clearly abnormal clinical examination, MRI…may be indicated depending on pain, severity, and disability (Bussieres et al 2007 pg 11).

Ankle
MRI or CT is recommended for the assessment of select patients with subacute or chronic ankle sprain; indications include those with limited improvement with non-operative therapy after 4-6 weeks, persistent pain with weight bearing, chronic feeling of instability, or injuries involving crepitus, catching or locking (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: moderate pg 206-207).

There is no recommendation for or against the use of MRA for the assessment of subacute or chronic ankle sprain (Hegmann et al [*ACOEM*] 2018, strength of evidence: no recommendation, insufficient evidence (I) / level of confidence: low pg 207).

There is no recommendation for or against the use of bone scans for patients with subacute or chronic ankle sprain (Hegmann et al [*ACOEM*] 2018, strength of evidence: no recommendation, insufficient evidence (I) / level of confidence: low pg 208).

Contrast-enhanced, fat-suppressed, 3D, fast-gradient (or equivalent) MRI may be useful in diagnosing synovitis and soft tissue impingement (Bussieres et al 2007 [D] pg 12).

MRI [is recommended] for os trigonum syndrome (Bussieres et al 2007 pg 12). *The PLE expert panel noted that MRI is useful in both anterior and posterior ankle impingement syndromes of which os trigonum is one* (PLE expert panel consensus opinion).

MRI [is recommended] …for peroneal tendinosis if there are signs of popping or clicking with foot eversion (Bussieres et al 2007 [D] pg 12).

In patients with *chronic ankle pain, ankle radiographs normal or nonspecific, suspected tendon abnormality, next study* the *American College of Radiology* recommends MRI ankle without IV contrast or ultrasound ankle (*usually appropriate*). Ultrasound-guided anesthetic injection ankle tendon sheath *may be appropriate* (Chang et al [*ACR*] 2018 variant 4).

In patients with *chronic ankle pain, ankle radiographs normal or nonspecific, suspected ankle instability, next study* the *American College of Radiology* recommends MRI ankle without IV contrast or MR arthrography ankle (*usually appropriate*). Ultrasound ankle, x-ray ankle stress views, or CT arthrography ankle *may be appropriate* (Chang et al [*ACR*] 2018 variant 5).

In patients with *chronic ankle pain, ankle radiographs normal or nonspecific, suspected ankle impingement syndrome, next study* the *American College of Radiology* recommends MRI ankle without IV contrast (*usually appropriate*). MR arthrography ankle, CT ankle without IV contrast, CT arthrography ankle, image-guided anesthetic injection ankle, or ultrasound ankle *may be appropriate* (Chang et al [*ACR*] 2018 variant 6).

In patients with *chronic ankle pain, ankle radiographs normal, pain of uncertain etiology, next study* the *American College of Radiology* recommends MRI ankle without IV contrast (*usually appropriate*). CT ankle without IV contrast, Tc-99m bone scan with SPECT/CT ankle, image-guided anesthetic injection ankle, or ultrasound ankle *may be appropriate* (Chang et al [*ACR*] 2018 variant 7).

Hindfoot

MRI [is recommended] if hindfoot-heel pain is unrelieved by 4 weeks of conservative care… (Bussieres et al 2007 pg 13).

MRI [is recommended] for sinus tarsi syndrome if unrelieved by 4 weeks of conservative care; it may be helpful for detecting subtle unilateral deformities (Bussieres et al 2007 pg 14).

MRI [is recommended] to differentiate accessory navicular from an avulsion fracture (Bussieres et al 2007 pg 14).

MRI is recommended for calcaneus fractures for identification of complications in the non-acute fracture patient with persistent pain more than 4 months after injury (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, evidence (C) / level of confidence: moderate pg 347).

MRI is recommended for evaluating Achilles tendinopathies including paratendonitis, tendinosis, and retrocalcaneal bursitis (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient

evidence (I) / level of confidence: moderate pg 18).

CT is not recommended for diagnosing Achilles tendinopathy (Hegmann et al [*ACOEM*] 2018, strength of evidence: not recommended, insufficient evidence (I) / level of confidence: moderate pg 19).

MRI is recommended for the evaluation of select patients with plantar fasciitis. MRI may be useful in the diagnosis of causes of heel pain other than plantar fasciitis, including calcaneal stress fracture, plantar fascia rupture, perifascial fluid, calcaneal spurs, avascular necrosis of the talar dome, joint fluid, ganglion cyst, and stress fracture of the talar neck (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: moderate pg 86).

The use of SPECT/CT is not recommended for the diagnosis of plantar heel pain (Hegmann et al [*ACOEM*] 2018, strength of evidence: not recommended, insufficient evidence (I) / level of confidence: low pg 86).

SPECT combined with CT can provide additional information compared with clinical diagnosis and conventional bone scintigraphy for the evaluation of impingement syndromes and soft-tissue pathology (Chang et al [*ACR*] 2017 pg 5).

Tarsal tunnel syndrome

Special investigations of tarsal tunnel syndrome include (Bussieres et al 2007 [D] pg 13):

- MRI for nerve and other soft tissue visualization
- CT for bony abnormalities

The routine use of MRI is not recommended for the initial evaluation of tarsal tunnel syndrome (TTS) (Hegmann et al [*ACOEM*] 2018, strength of evidence: not recommended, insufficient evidence (I) / level of confidence: high pg 190).

MRI is recommended for the diagnosis of select cases of clinically suspected TTS that has failed conservative management or if a mass lesion is suspected (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: low pg 190).

<u>Clinical/Imaging notes:</u>

- For most cases presenting with true foot and ankle disorders, special studies are usually not needed until after a period of conservative care and observation. Most ankle and foot problems improve quickly once any red flags (fracture, dislocation, neurovascular compromise, tendon rupture, or neoplastic, metabolic, inflammatory or infection disorders) are ruled out (Hegmann et al [*ACOEM*] 2018).
- Ankle pain is considered chronic when symptoms persist (4-6) weeks and can be caused by a variety of osseous or soft-tissue abnormalities, either alone or in combination (Chang et al [*ACR*] 2018; Bussieres 2007; PLE expert panel consensus opinion).
- Ultrasound for chronic ankle instability or assessment of ankle sprain that has not demonstrated improvement in 4-6 weeks may be reasonable, although there is insufficient information to recommend it over CT or MRI (Hegmann et al [*ACOEM*] 2018).
- Although diagnosing non-rupture Achilles disorders is largely based on a careful history and examination, diagnostic imaging may be required to verify a clinical suspicion or to exclude other musculoskeletal disorders (Hegmann et al [*ACOEM*] 2018):
    - Ultrasound is recommended for diagnosing Achilles tendinopathy and may be

particularly useful for differentiation of paratenonitis and tendinosis and for identifying fluid in the retrocalcaneal bursa (Hegmann et al [*ACOEM*] 2018).

- Imaging plays a limited role in plantar fasciitis and is generally reserved for select cases to rule out other causes of heel pain or to establish the diagnosis when it is in doubt (*ACOEM* 2015):
    - The routine use of radiographs is not recommended for diagnosing plantar fasciitis or plantar heel pain, but may be recommended when there is suspicion of fracture or tumor, or for non-routine confirmation of diagnosis (Hegmann et al [*ACOEM*] 2018).
    - Ultrasound may be the initial step for imaging of plantar fasciitis, particularly when clinical diagnosis is uncertain or after no improvement from a course of conservative treatment (Bussieres et al 2007; Hegmann et al [*ACOEM*] 2018).
- In addition to the diagnostic capabilities of ultrasound, when a tendon abnormality or impingement syndrome is detected, a fluoroscopic or ultrasound-guided injection may be appropriate (Chang et al [*ACR*] 2018).
- Ultrasound imaging should be conducted by qualified personnel and with proper equipment (PLE expert panel consensus opinion).

<u>Evidence update (June 2017 - present):</u>
Cao et al (2018) conducted a systemic review with meta-analysis to analyze studies on diagnostic accuracy of different imaging techniques of chronic lateral ligament injury, using arthroscopic or surgical findings as the gold standard. Fifteen studies with a total of 695 participants were included. Data were extracted to calculate pooled sensitivity and specificity of MRI, ultrasonography (US), stress radiography, and arthrography. Pooled sensitivities in diagnosing chronic anterior talofibular ligament (ATFL) injury were 0.83 [0.78, 0.87] for MRI, 0.99 [0.96, 1.00] for US, and 0.81 [0.68, 0.90] for stress radiography. Pooled specificities in diagnosing chronic ATFL injury were 0.79 [0.69, 0.87] for MRI, 0.91 [0.82, 0.97] for US, and 0.92 [0.79, 0.98] for stress radiography. Pooled sensitivities in diagnosing chronic calcaneofibular ligament (CFL) injury were 0.56 [0.46, 0.66] for MRI, 0.94 [0.85, 0.98] for US, and 0.90 [0.73, 0.98] for arthrography. Pooled specificities in diagnosing chronic CFL injury were 0.88 [0.82, 0.93] for MRI, 0.91 [0.80, 0.97] for US, and 0.90 [0.77, 0.97] for arthrography. The authors conclude that US manifested high diagnostic accuracy in diagnosing chronic lateral ankle ligament injury, and that clinicians should be aware of MRI's limitations in detecting chronic CFL injuries (low level of evidence).

Tan et al (2017) evaluated the accuracy of MRI in diagnosing lateral ankle ligament injuries and the effect of differences in time duration from injury to MRI. 82 patients with residual symptoms of ankle pain, swelling, or instability after > 6 weeks of conservative treatment were included. Patients were divided into acute (< 3 months) or chronic (> 3 months) groups based on injury interval. Findings were classified as normal, partial, or complete tears of the ATFL and the CFL. The accuracy of MRI for partial and complete tears of the ATFL was 74% and 79%, respectively, with sensitivity and specificity of 64% and 86% for partial tears, and 78% and 80% for complete tears, respectively. Accuracy of MRI was 66% and 88% for partial and complete tears of the CFL with a sensitivity and specificity of 41% and 87% for partial tears, and 61% and 95% for complete tears, respectively. A decrease in MRI accuracy was observed in the chronic group. The authors conclude that MRI is accurate in diagnosing ATFL injuries, and it is specific but not sensitive for CFL tears. The accuracy is higher in the acute setting of 3 months or less from time of injury to MRI (low level of evidence).

Kim et al (2015) analyzed the reliability and validity of MRI for detection of anterior talofibular ligament (ATFL) injuries in chronic lateral ankle instability by comparing its findings with arthroscopic findings. 79 patients who underwent MRI followed by subsequent arthroscopy for various ankle disorders were included. On arthroscopy, 55 ATFL injuries were identified. The interobserver reliability of detecting

ATFL injuries with MRI was excellent (intraclass correlation coefficient, 0.915). MRI, as interpreted by readers A and B, showed a sensitivity of 83.6% and 76.4%, respectively; specificity of 91.7% and 83.3%, respectively; negative predictive value of 71.0% and 60.6%, respectively; positive predictive value of 95.8% and 91.3%, respectively; and accuracy of 86.1% and 78.5%, respectively. The authors conclude that MRI has excellent interobserver reliability for detecting ATFL injuries in patients in whom there is a clinical suspicion of chronic lateral ankle instability (low level of evidence).

Ozer et al (2019) sought to determine a possible relationship between ankle impingement syndrome and prevalence of os trigonum and osteochondral lesions of talus (OCLT). 333 patients clinically considered to be diagnosed with ankle impingement syndrome and had ankle MRI were included. Patients had no history of major ankle trauma, and had persistence of complaints after > 3 weeks of conservative treatment. Presence of anterior ankle impingement syndrome (AAIS), posterior ankle impingement syndrome (PAIS), os trigonum, OCLT, and location of OCLT were evaluated. The prevalence of os trigonum was 1.3% in patients with PAIS(-) AAIS(+), 7.7% in patients with PAIS(-) AAIS(-), 63.3% in patients with PAIS(+) AAIS(-), and 81.1% in patients with PAIS(+) AAIS(+) ($p < .001$). The prevalence of OCLT was 41.3% in patients with PAIS(-) AAIS(+), 23.1% in patients with PAIS(-) AAIS(-), 18.3% in patients with PAIS(+) AAIS(-), and 27% in patients with PAIS(+) AAIS(+) ($p= .005$). The authors conclude that, in patients with isolated PAIS and in AAIS combined with PAIS, the prevalence of os trigonum was 63.3% and 81.1%, respectively, which is more common than previously reported (low level of evidence).

Ankle and/or hind foot pain with suspected stress or insufficiency reaction/fracture and negative or indeterminate radiographs:

- **Green** – MRI without IV contrast
- **Yellow** – Planar bone scan or bone scan/SPECT or bone scan/SPECT/CT* in patients with equivocal MRI findings, or for patients unable to undergo MRI
- **Yellow** – CT without IV contrast in patients with equivocal MRI findings, or in patients with increased uptake on planar bone scan or bone scan/SPECT or bone scan/SPECT/CT* who are unable to undergo MRI
- **Red** – MRI with IV contrast, MRI without and with IV contrast, MR arthrography, CT with IV contrast, CT without and with IV contrast, CT arthrography, PET, PET/CT

Level of Evidence: MRI without contrast: moderate-high; CT without contrast, bone scan with SPECT: low-moderate; MRI without and with contrast, MRI with contrast, MR arthrography, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
*Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
MRI is recommended for suspected acute occult fracture of the talus and calcaneus (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: moderate pg 347).

If radiograph appears normal with clearly abnormal clinical examination, MRI…may be indicated depending on pain, severity, and disability (Bussieres et al 2007 pg 11).

MRI [is recommended] in hindfoot-heel pain if unrelieved by 4 weeks of conservative care… (Bussieres et al 2007 pg 13).

CT may be useful to evaluate healing of a confirmed stress fracture (PLE expert panel consensus opinion).

Bone scans are recommended for select patients with acute ankle sprain and indication of suspected stress fracture… (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: low pg 208).

Bone scans are recommended for diagnosis of occult and stress [calcaneus] fractures in select patients. A bone scan may be reasonable for those with high clinical suspicion but with negative x-ray and CT scan (Hegmann et al [*ACOEM*] 2018, strength of recommendation: recommended, insufficient evidence (I) / level of confidence: high pg 348).

[For acute ankle and foot injuries and positive findings on the OAR] nuclear medicine is recommended for persisting symptoms to exclude stress fracture (Bussieres et al 2007 pg 28).

In patients with *chronic ankle pain, ankle radiographs normal, pain of uncertain etiology, next study* the *American College of Radiology* recommends MRI ankle without IV contrast (*usually appropriate*). CT ankle without IV contrast, Tc-99m bone scan with SPECT/CT ankle, image-guided anesthetic injection ankle, or ultrasound ankle *may be appropriate* (Chang et al [*ACR*] 2018 variant 7).

In patients with *suspected stress (insufficiency) fracture of lower extremity…negative radiographs, next imaging study* the *American College of Radiology* recommends MRI without IV contrast (9), [delayed] x-ray after 10-14 days (7), CT without IV contrast (5), or Tc-99m bone scan (5) (Bencardino et al [*ACR*] 2017* variant 9).

* This guideline did not pass the AGREE II cutoff of 90. It was included, however, because of its direct relevance to the stress fracture scenario.

Clinical/Imaging notes:

- Stress fractures are thought to be caused by repetitive loading to the bone rather than a discrete event. History of stress fractures often includes increased physical activity or intensity of activity preceding symptoms (Hegmann et al [*ACOEM*] 2018).
- Patients at high-risk of stress (fatigue or insufficiency) fracture include athletes (runners, dancers), middle-aged or elderly patients, and those on long-term corticosteroids (Bussieres et al 2007).
- Initial diagnostic imaging includes radiographs, which generally require 2 to 4 weeks for a stress fracture to show up (Chang et al [*ACR*] 2018; Hegmann et al [*ACOEM*] 2018).
    - If initial radiographs are inconclusive and stress fracture is suspected, patients should be re-radiographed after a period of restricted use before proceeding to advanced imaging (Bussieres et al 2007).
- High-field MRI with fat suppression or inversion recovery protocol [for stress fracture] is as sensitive as nuclear medicine and is the procedure of choice for making an early diagnosis (Bencardino et al [*ACR*] 2017; Bussieres et al 2007).
- CT is not typically used as a first- or second-line imaging tool but may offer an adjunctive role when other imaging modalities are equivocal (Bencardino et al [*ACR*] 2017).
- DEXA scanning should be considered with stress fractures or insufficiency fractures in patients without a known diagnosis of osteoporosis (PLE expert panel consensus opinion).

Evidence update (December 2014 - present):

No new low, moderate or high level evidence addressing the utility of advanced imaging in this clinical scenario.

Nontraumatic (chronic) ankle and/or hind foot pain with moderate to severe osteoarthritis (OA) on initial radiographs:

- **Green** – ‡
- **Yellow** – MRI without IV contrast or CT without IV contrast in patients with new-onset severe pain, mechanical symptoms, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Yellow** – CT arthrography if the patient is unable to undergo MRI and there is new-onset severe pain, mechanical symptoms, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Yellow** – MRI without IV contrast, CT without IV contrast or CT arthrography for surgical planning in patients considering ankle arthroplasty or chondroplasty
- **Yellow** – MR arthrography or CT arthrography for surgical planning in patients who are considering partial ankle arthroplasty or chondroplasty
- **Red** – MRI without and with IV contrast, MRI with IV contrast, CT with IV contrast, CT without and with IV contrast, planar bone scan, bone scan/SPECT, bone scan/SPECT/CT* PET, PET/CT

‡ Advanced imaging is not recommended for the routine diagnosis, management, or follow-up of osteoarthritis of the ankle (Sakellariou et al [EULAR] 2017).

Level of Evidence: MRI without contrast: moderate; CT without contrast: very low; MRI without and with contrast, MRI with contrast, CT with contrast, CT without and with contrast, MR arthrography, CT arthrography, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
*Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Conventional radiography is useful for the diagnosis and evaluation of osteoarthritis in patients with new onset symptoms or with patients with progression of symptoms (PLE expert panel consensus opinion).

Imaging is not required to make the diagnosis in patients with typical presentation of OA (usage related pain, short duration morning stiffness, age > 40, symptoms affecting one or a few joints) (Sakellariou et al [*EULAR*] 2017; level III-IV evidence; level of agreement: 8.7 pg 2).

In atypical presentations, imaging is recommended to help confirm the diagnosis of OA and/or make alternative or additional diagnoses (Sakellariou et al [*EULAR*] 2017; level IV evidence; level of agreement: 9.6 pg 2).

Routine imaging in osteoarthritis follow-up is not recommended; however, imaging is recommended if there is unexpected rapid progression of symptoms or changes in clinical characteristics to determine if this relates to osteoarthritis or an additional diagnosis (Sakellariou et al [*EULAR*] 2017; level III-IV evidence; level of agreement: 8.8 pg 2).

If imaging is needed, conventional radiography should be used before other modalities. To make additional diagnoses, soft tissues are best imaged by ultrasound or MRI and bone by CT or MRI (Sakellariou et al [*EULAR*] 2017; level III-IV evidence; level of agreement: 8.7 pg 2).

In patients with atypical presentations, rapid progression of symptoms or changes in the clinical characteristics, CT arthrography may be considered if the patient is unable to undergo MRI (PLE expert panel consensus opinion).

In patients with *chronic ankle pain, multiple sites of degenerative joint disease in the hindfoot detected by ankle radiographs, next study* the *American College of Radiology* does not recommend any advanced imaging as *usually appropriate*. Image-guided anesthetic injection ankle and hindfoot, MRI ankle and hindfoot without IV contrast, or CT ankle and hindfoot without IV contrast *may be appropriate* (Chang et al [*ACR*] 2018 variant 2).

MRI without contrast, CT without contrast or CT arthrography may be useful for surgical planning in patients considering ankle arthroplasty or chondroplasty (PLE expert panel consensus opinion).

For patients being considered for partial ankle arthroplasty or chondroplasty, MR arthrography or CT arthrography may be considered (PLE expert panel consensus opinion).

<u>Clinical/Imaging notes:</u>

- When multiple sites of osteoarthritis are present, it may be important to determine which joint is the cause of the symptoms (Chang et al [*ACR*] 2018).
- According to current evidence, imaging features do not predict non-surgical treatment response and imaging cannot be recommended for this purpose (Sakellariou et al [*EULAR*] 2017 page 5).
- When degenerative changes of the ankle joint are diagnosed based on radiographs, MRI may be considered as the next best examination to evaluate cartilage integrity, bone marrow, and associated soft tissues, such as ligaments and tendons, if these injuries are clinically suspected (Chang et al [*ACR*] 2018).
- CT without contrast may be helpful to visualize subchondral cysts (Chang et al [*ACR*] 2018).
- Ultrasound is not routinely used for the evaluation of degenerative joint disease (Chang et al [*ACR*] 2018).

<u>Evidence update (June 2017 - present):</u>

No new low, moderate or high level evidence addressing the utility of advanced imaging in this clinical scenario.

Ankle and/or hind foot pain with suspicion of osteochondral defect (OCD) or avascular necrosis (osteonecrosis):

- **Green** – MRI without IV contrast
- **Yellow** – CT without IV contrast for surgical planning and/or in patients who are unable to undergo MRI
- **Yellow** – Planar bone scan or bone scan/SPECT or bone scan/SPECT/CT* in patients unable to undergo MRI or when MRI is expected to be non-diagnostic
- **Yellow** – CT arthrography or MR arthrography for lesion detection and/or assessment for instability of OCD fragment
- **Yellow** – MRI without and with IV contrast to assess vascularized bone in patients with AVN
- **Yellow** – MRI with IV contrast after recent** MRI without IV contrast to assess vascularized bone in patients with AVN
- **Red** – CT with IV contrast, CT without and with IV contrast, PET, PET/CT

**Recent is typically defined as < 1 month (PLE expert panel consensus opinion).

Level of Evidence: MRI without contrast: moderate; CT without contrast, bone scan with SPECT/CT: low; MRI without and with contrast, MRI with contrast, MR arthrography, CT with contrast, CT without and with contrast, CT with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
*Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
General indications for advanced imaging in extremity disorders – osteonecrosis: MRI (first choice). CT or nuclear medicine (second choice, determined on a case-by-case basis) (Bussieres et al 2007 pg 32).

[In patients with hindfoot pain] MRI can [be used to] exclude diagnoses such as avascular necrosis of the talar dome (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: moderate pg 86).

In case of suspicion of high-grade ligament injuries, osteochondral defects, syndesmotic injuries and occult fractures, an MRI can be performed because of its excellent sensitivity and specificity for visualizing these injuries (Vuurberg et al. 2018 pg 6).

In patients with *chronic ankle pain, ankle radiographs normal, suspected osteochondral lesion, next study* the *American College of Radiology* recommends MRI ankle without IV contrast (*usually appropriate*). CT arthrography ankle, MR arthrography ankle, Tc-99m bone scan with SPECT/CT ankle, and/or CT ankle without IV contrast *may be appropriate* (Chang et al [*ACR*] 2018 variant 3).

Clinical/Imaging notes:
- Osteochondral injuries may involve the talar dome and, less commonly, the tibial plafond and tarsal navicular bone. If this injury is associated with osseous cyst or osteochondral defect, it may be seen on radiographs (Chang et al [*ACR*] 2018).

- CT arthrography may be more accurate than MR arthrography for the identification of osteochondral abnormalities (Chang et al [*ACR*] 2018).
- The introduction of contrast into the ankle joint prior to CT or MRI will outline a cartilage surface defect, which can assist in lesion detection and assessment for instability (Chang et al [*ACR*] 2018).
- When osteochondral injuries are associated with fracture, osseous cyst, or osteochondral defect, bone scan (with SPECT/CT) may show the abnormality (Chang et al [*ACR*] 2018).

Evidence update (February 2016 – Present):
You et al (2016) evaluated prevalence and common location of coexisting osteochondral lesion of the distal tibia and fibula and of associated abnormalities of ankle ligaments and tendons on MRI in patients with an osteochondral lesion of the talus (OLT). MRIs of 297 feet with OLTs were included. Two readers reviewed the MRIs independently for presence of an osteochondral lesion of the distal tibia and fibula and for concomitant ligament and tendon injuries. If an osteochondral lesion of the distal tibia and fibula was present, the reviewers also recorded the location (zones 1–10) and stage. Readers A and B identified 61 (20.5%) and 47 (15.8%) coexisting osteochondral lesions of the distal tibia and fibula, respectively, with good interobserver ($\kappa = 0.73$) and excellent intraobserver ($\kappa = 0.97$) reliabilities. Frequency of osteochondral lesions of the distal tibia and fibula was not significantly different according to location or stage of OLT. Abnormalities in the tibialis posterior tendon and in the anterior and posterior talofibular, calcaneofibular, and deltoid ligaments were significantly more common in patients with a coexisting osteochondral lesion of the distal tibia and fibula than in those with an isolated OLT ($p < 0.05$). The authors conclude that a coexisting osteochondral lesion of the distal tibia and fibula is not rare on MRI in patients with an OLT and is related to a higher frequency of concomitant ankle ligament and tendon injuries (low level of evidence). *The PLE expert panel noted that MRI is useful in the diagnosis of associated soft tissue injuries in patients with coexisting osteochondral lesions of the tibia, fibula and talus* (PLE expert panel consensus opinion).

Kirschke et al (2016) sought to retrospectively determine the diagnostic value and reliability of CTA of the ankle in the evaluation of osteochondral defects, in comparison to conventional MRI. 79 patients had CTA and MRI of the ankle; in 17 cases, surgical reports with statements on cartilage integrity were available. Cartilage lesions and bony defects at talus and tibia were scored according to defect depth and size by two radiologists. On CTA, 41/79 and 31/79 patients had full thickness cartilage defects at the talus and at the tibia, respectively. MRI detected 54% of these defects. For the detection of full thickness cartilage lesions, interobserver agreement was substantial (0.72 ± 0.05) for CTA and moderate (0.55 ± 0.07) for MRI. In surgical reports, 88–92% and 46–62% of full thickness defects detected by CTA and MRI were described. CTA findings changed the further clinical management in 15.4% of cases. The authors conclude that, compared to conventional MRI, CTA improves detection and visualization of cartilage defects at the ankle and is a relevant tool for treatment decisions in unclear cases (low level of evidence).

Nosewicz et al (2016) explored the value of CT in detecting early osteochondral lesions (OCL) and investigated if an association between type of fracture and occurrence of osteochondral lesions exists. 100 ankle fractures requiring operative treatment were prospectively included, and multidetector CT was performed postoperatively. For each OCL, the location, size, and Loomer OCL classification (CT modified Berndt and Harty classification) were determined. The Foot and Ankle Outcome Scoring (FAOS) was used for clinical outcome at 1 year. OCLs were found in 10/100 ankle fractures (10.0%); all were solitary talar lesions. Four OCLs were located posteromedial, 4 posterolateral, 1 anterolateral, and 1 anteromedial. There were 2 type I OCLs (subchondral compression), 6 type II OCLs (partial, nondisplaced

fracture) and 2 type IV OCLs (displaced fracture). Mean OCL size (largest diameter) was 4.4 ± 1.7 mm (range, 1.7-6.2 mm). Analysis showed no significant association between ankle fracture type and occurrence of OCLs. OCLs occurred only in Lauge-Hansen stage III/IV ankle fractures. There were no significant differences in FAOS outcome between patients with or without OCLs (low level of evidence). *The PLE expert panel was concerned that the follow-up period was insufficient to detect the incidence of post-traumatic osteoarthritis* (PLE expert panel consensus opinion).

Suspicion for septic arthritis, osteomyelitis, or neuropathic arthropathy (Charcot foot /ankle)* with indeterminate radiographs:

- **Green** – MRI without and with IV contrast** or MRI without IV contrast
- **Yellow** – FDG-PET or FDG-PET/CT or WBC scintigraphy with multiphase bone scan (with or without SPECT/CT***) in patients unable to undergo MRI or if MRI is nondiagnostic
- **Yellow** – WBC scintigraphy with sulfur colloid marrow scan in patients with indwelling hardware causing artifact on MRI
- **Yellow** – CT with IV contrast or CT without IV contrast to evaluate for soft tissue-gas, sequestra, or foreign body, or for patients unable to undergo MRI
- **Yellow** – Multiphase bone scan to further evaluate foot ulceration(s) for bony involvement
- **Red** – MRI with IV contrast (postcontrast images only), MR arthrography, CT without and with IV contrast, CT arthrography, planar bone scan, bone scan/SPECT, bone scan/SPECT (without WBC scintigraphy)

*This scenario addresses infections in both non-DM and DM patient groups.

**MRI with IV contrast is useful to evaluate for soft tissue abscess.

Level of Evidence: MRI without contrast, MRI without and with contrast: moderate; CT without contrast, bone scan, WBC scintigraphy, FDG-PET/CT, CT with contrast: low; MRI with contrast, MR arthrography, CT without and with contrast, CT arthrography: insufficient

Notes concerning applicability and/or patient preferences:
***Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
In [non-DM] patients with *suspected osteomyelitis, septic arthritis, or soft tissue infection, first study* the *American College of Radiology* does not recommend any advanced imaging (Beaman et al [*ACR*] 2016 variant 1).

For *suspected osteomyelitis of the foot in patients with diabetes mellitus, initial imaging*, the *American College of Radiology* does not recommend any advanced imaging (Walker et al [*ACR*] 2019 variant 1).

In a person with diabetes and suspected osteomyelitis of the foot, if a plain x-ray and clinical and laboratory findings are most compatible with osteomyelitis, the *International Working Group on the Diabetic Foot* (*IWGDF*) recommends no further imaging of the foot to establish the diagnosis (Lipsky et al [*IWGDF*] 2019, strong recommendation / low level of evidence pg 4).

If osteomyelitis is suspected in a person with diabetes but is not confirmed by initial x-ray, consider an MRI to confirm the diagnosis (*NICE* 2015 p 23).

If the diagnosis of osteomyelitis remains in doubt, consider ordering an advanced imaging study, such as MRI scan, 18F-FDG-PET/CT or leukocyte scintigraphy (with or without CT) (Lipsky et al [of *IWGDF*] 2019, strong recommendation / moderate level of evidence pg 4).

For patients who require additional (i.e., more sensitive or specific) imaging, particularly when soft

tissue abscess is suspected or the diagnosis of osteomyelitis remains uncertain, MRI is recommended as the study of choice (Lipsky et al [*IDSA*] 2012 p 152-153, strong recommendation / moderate level of evidence; Hingorani et al [SVS] 2016, grade 1B page 4S).

- When MRI is unavailable or contraindicated, consider the combination of a radionuclide bone scan and a labeled white blood cell scan as the best alternative (Lipsky et al [*IDSA*] 2012 p 152-153, weak recommendation / low level of evidence).

MRI is recommended as a diagnostic imaging test for diabetic foot osteomyelitis (DFO). However, MRI is not always necessary for diagnosing or managing DFO (Lipsky et al [*IDSA*] 2012, p 152-153 strong recommendation / low level of evidence).

- If MRI is unavailable or contraindicated, consider a leukocyte or antigranulocyte scan, preferably combined with a bone scan (Lipsky et al [IDSA] 2012 p 152-153, weak recommendation / moderate level of evidence; Hingorani et al [*SVS*] 2016, grade 2B page 4S).

In [non-DM] patients with *soft-tissue or juxta-articular swelling, suspected soft-tissue infection, additional imaging following radiographs* the *American College of Radiology* recommends MRI without and with IV contrast (9), MRI without IV contrast (7), CT with IV contrast (6), or ultrasound (5) (Beaman et al [*ACR*] 2016 variant 2).

In [non-DM] patients with *soft-tissue or juxta-articular swelling with cellulitis and a skin lesion, injury, wound, ulcer, or blister, suspected osteomyelitis, additional imaging following radiographs* the *American College of Radiology* recommends MRI without and with IV contrast (9), MRI without IV contrast (7), CT with IV contrast (7), labeled leukocyte scan and Tc-99m sulfur colloid marrow scan (6), Tc-99m 3-phase bone scan and labeled leukocyte scan (6), CT without IV contrast (5), or Tc-99m 3-phase bone scan (5) (Beaman et al [*ACR*] 2016 variant 4).

In [non-DM] patients with *soft-tissue or juxta-articular swelling with a history of prior surgery, suspected osteomyelitis or septic arthritis, additional imaging following radiographs* the *American College of Radiology* recommends aspiration (9), MRI without and with IV contrast (9), MRI without IV contrast (7), CT with IV contrast (6), CT without IV contrast (5), or labeled leukocyte scan and Tc-99m sulfur colloid marrow scan (5) (Beaman et al [*ACR*] 2016 variant 5).

In [non-DM] patients with *pain and swelling or cellulitis associated with site of previous nonarthroplasty hardware, suspected osteomyelitis or septic arthritis, additional imaging following radiographs* the *American College of Radiology* recommends aspiration (9), MRI without and with IV contrast (9), MRI without IV contrast (8), CT with IV contrast (7), labeled leukocyte scan and Tc-99m sulfur colloid marrow scan (7), or CT without IV contrast (5) (Beaman et al [*ACR*] 2016 variant 6).

In [non-DM] patients with *draining sinus (not associated with a joint prosthesis), suspected osteomyelitis, additional imaging following radiographs* the *American College of Radiology* recommends MRI without and with IV contrast (9), MRI without IV contrast (7), CT with IV contrast (6), or CT without IV contrast (6) (Beaman et al [*ACR*] 2016 variant 7).

In [non-DM] patients with *clinical examination suggesting crepitus, suspected soft-tissue gas*, *first study* the *American College of Radiology* recommends x-ray (9), CT with IV contrast (5), or CT without IV contrast (5) (Beaman et al [*ACR*] 2016 variant 8).

If acute Charcot arthropathy is suspected, arrange a weight-bearing x-ray of the affected foot and ankle.

Consider an MRI if the x-ray is normal but Charcot arthropathy is still suspected (*NICE* 2015 p24).

MRIs have been shown to provide more information, are hypothesized to improve staging, have not been shown to change management, but may be selectively recommended [for neuropathic arthropathy] (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) / level of confidence: low pg 184).

For *soft-tissue swelling <u>without</u> ulcer, suspected osteomyelitis or early neuropathic arthropathy changes of the foot in patients with diabetes mellitus, additional imaging following radiographs*, the *American College of Radiology* recommends MRI foot without and with IV contrast or MRI foot without IV contrast (*usually appropriate*). CT foot with IV contrast, CT foot without IV contrast, Tc-99m 3-phase bone scan and In-111 WBC scan (with or without SPECT/CT) foot, or FDG-PET/CT foot *may be appropriate* (Walker et al [*ACR*] 2019 variant 2).

For *soft-tissue swelling <u>with</u> ulcer, suspected osteomyelitis of the foot in patients with diabetes mellitus with or without neuropathic arthropathy, additional imaging following radiographs*, the *American College of Radiology* recommends MRI foot without and with IV contrast or MRI foot without IV contrast (*usually appropriate*). CT foot with IV contrast, CT foot without IV contrast, Tc-99m 3-phase bone scan and In-111 WBC scan foot, Tc99m 3-phase bone scan and In-111 WBC scan with SPECT/CT foot, Tc-99m 3-phase bone scan foot, FDG-PET/CT foot, or In-111 WBC scan foot may be appropriate (Walker et al [*ACR*] 2019 variant 3).

Bone scans are indicated for those [foot ulcerations] with further questions of bony involvement, particularly with indeterminate x-rays (Hegmann et al [*ACOEM*] 2018, strength of evidence: recommended, insufficient evidence (I) pg 147).

<u>Clinical/imaging notes:</u>

- Patients with septic arthritis typically present with pain localized to a single joint, erythema, soft-tissue swelling and diminished range of motion (Beaman et al [*ACR*] 2016).
- Radiographs are indicated for those [foot ulcerations] with concerns about possible underlying bony involvement, particularly including concerns about osteomyelitis (Hegmann et al [*ACOEM*] 2018).
- Radiographs are recommended for diagnostic testing of Charcot joint (neurogenic arthropathy) (Hegmann et al [*ACOEM*] 2018).
- Patients presenting with a new diabetic foot infection should have plain radiographs of the affected foot to look for bony abnormalities (deformity, destruction) as well as for soft tissue gas and radio-opaque foreign bodies (Lipsky et al [*IDSA*] 2012 p 136; Hingorani et al [*SVS*] 2016 page 4S).
    - Plain radiographs of the foot have relatively low sensitivity and specificity for confirming or excluding osteomyelitis. Clinicians might consider using serial plain radiographs to diagnose or monitor suspected diabetic foot osteomyelitis (Lipsky et al [*IDSA*] 2012 p136; Hingorani et al [*SVS*] 2016).
- In a person with diabetes and suspected osteomyelitis of the foot, using a combination of the probe-to-bone test, the erythrocyte sedimentation rate (or C-reactive protein and/or procalcitonin), and plain radiographs are recommended as the initial studies to diagnose osteomyelitis (Lipsky et al [*IDSA*] 2012).
    - Osteomyelitis may be present in a person with diabetes despite normal inflammatory markers, radiographs or probe-to-bone testing (*NICE* 2016 p 23).

- Depending on the patient setting, advanced imaging for diagnosing osteomyelitis is not needed in many patients. When needed, MRI, with a sensitivity of about 0.9 and specificity of about 0.8, has been the most widely used test for decades (Lipsky et al [*IWGDF*] 2019; Walker et al [*ACR*] 2019).
- Imaging plays a central role in characterizing soft-tissue and osseous infections by identifying the location, evaluating the extent of involvement, and detecting complications (Beaman et al [*ACR*] 2016).
- In patients with suspected joint infection, joint aspiration is recommended for diagnosis. Ultrasound can be used to confirm the presence of a joint effusion. Fluoroscopy or ultrasound may be used to guide diagnostic joint aspirations (Beaman et al [*ACR*] 2017; PLE expert panel consensus opinion).
- FDG-PET/CT has a potentially important role in diagnosing deep soft-tissue infection and osteomyelitis and differentiating neuropathic arthropathy. Fused FDG-PET/CT allows correct differentiation between osteomyelitis and soft-tissue infection (Walker et al [*ACR*] 2019).
- Nuclear medicine examinations may be useful in cases where MRI is contraindicated, infection is multifocal, or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery (Beaman et al [*ACR*] 2017; Walker et al [*ACR*] 2019).
- Skeletal scintigraphy is highly sensitive but lacks specificity. Bone scans can become positive as early as one–two days after the onset of clinical symptoms. A 3- or 4-phase bone scan aids in distinguishing cellulitis from osteomyelitis. The addition of single-photon emission CT (SPECT) or SPECT/CT improves the accuracy of radionuclide scintigraphy, facilitating the differentiation between bone and soft-tissue infection (Beaman et al [*ACR*] 2017).
- In patients with orthopedic hardware, radiolabeled leukocyte in combination with sulfur colloid scans may be useful to assess osteomyelitis (Beaman et al [*ACR*] 2017; Walker et al [*ACR*] 2019).

<u>Evidence update (November 2017 - present):</u>
Liao et al (2018) investigated the diagnostic value of dynamic contrast-enhanced MRI (DCE-MRI) in differentiating osteomyelitis from acute neuropathic arthropathy in the diabetic foot. 30 patients (mean age 51) underwent clinical exam, labs, and DCE-MRI. The DCE-MRI parameters (Ktrans, Kep and Ve) of the regions of acute neuropathic arthropathy and osteomyelitis were calculated. Ktrans, Kep and Ve values of the osteomyelitic regions were higher than those of the acute neuropathic arthropathy regions, and significant differences were found between groups. ROC analysis showed that Ktrans and Ve performed best in differentiating osteomyelitis from acute neuropathic arthropathy, both with area under the curve of 0.938. The authors conclude that DCE-MRI may provide reproducible parameters that can reliably differentiate osteomyelitis from acute neuropathic arthropathy (low level of evidence). *The PLE expert panel noted that, although promising, this was a cohort study which may overstate the accuracy of the technique, and the availability of the technology may be limited* (PLE expert panel consensus opinion).

Ankle and/or hind foot pain with suspicion of foreign body and negative or indeterminate radiographs:

- **Green** – ‡
- **Yellow** – CT without IV contrast
- **Yellow** – MRI without IV contrast or MRI without and with IV contrast to evaluate affiliated soft-tissue infection to include abscess
- **Yellow** – MRI with IV contrast to evaluate for suspected soft tissue infection to include abscess in patients with recent* MRI without IV contrast
- **Yellow** – CT with IV contrast or CT without and with IV contrast to evaluate for suspected soft tissue infection to include suspected abscess in patients unable to undergo MRI
- **Red** – Planar bone scan, bone scan/SPECT, bone scan/SPECT/CT** PET, PET/CT, MR arthrography, CT arthrography

‡ When appropriate expertise and equipment is available, ultrasound is the next imaging procedure of choice to evaluate for a foreign body

*Recent is typically defined as < 1 month (PLE expert panel consensus opinion).

Level of Evidence: CT without contrast: moderate; MRI without contrast, MRI without and with contrast: low; bone scan; MRI with contrast, MR arthrography, CT arthrography, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
**Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
In patients with *acute injury to the foot, physical examination is concerning for penetrating trauma with a foreign body in the soft tissues, radiographs of the foot are negative, next best study* the *American College of Radiology* recommends ultrasound (9), CT without IV contrast (5), or MRI without IV contrast (5) (Bancroft et al [*ACR*] 2015*** variant 9).

In patients with *soft-tissue or juxta-articular swelling with a history of puncture wound, suspected foreign body, negative radiographs* the *American College of Radiology* recommends ultrasound (8), CT without IV contrast (7), MRI without and with IV contrast (7), CT with IV contrast (6), or MRI without IV contrast (6) (Beaman et al [*ACR*] 2016 variant 3).

The IDSA (Lipsky et al 2012) recommends all patients presenting with a new diabetic foot infection to have plain radiographs of the affected foot to look for bony abnormalities (deformity, destruction) as well as for soft tissue gas and radio-opaque foreign bodies (*strong recommendation, moderate level of evidence*). They recommend using MRI as the study of choice for patients who require further (i.e., more sensitive or specific) imaging…(*strong recommendation, moderate level of evidence* pg 136).

***This guideline did not pass the AGREE II cutoff of 90. It was included, however, because of its direct relevance to the foreign body scenario.

Clinical/imaging notes:

- In patients with a puncture wound, any imaging evaluation should determine presence or absence of a retained foreign body (Beaman et al [*ACR*] 2016).
- Radiographs are indicated for initial imaging, especially if the composition of the material is unknown, and are well suited in detecting radiodense foreign bodies such as metal, graphite, and stone (Beaman et al [*ACR*] 2016; Walker et al [*ACR*] 2019).
- Both ultrasound and CT allow for precise foreign body localization (Beaman et al [*ACR*] 2016).
- Ultrasound [or CT] excels in detecting radiolucent foreign bodies (e.g., wood or plastic) (Beaman et al [*ACR*] 2016; Walker et al [*ACR*] 2019).
- If MRI is used, GRE T2*-weighted or susceptibility weighted sequence should be added, as it is sensitive for blood products and microscopic metal, either of which may be helpful in locating an otherwise difficult to locate foreign body (PLE expert panel consensus opinion).

Evidence update (February 2016 - present):

No new low, moderate or high level evidence addressing the utility of advanced imaging in this clinical scenario.

Ankle and/or hind foot pain with suspected or known hind foot (tarsal) coalition following radiographs:

- **Green** – MRI without IV contrast or CT without IV contrast
- **Orange** – Planar bone scan or bone scan/SPECT or bone scan/SPECT/CT*, except to further evaluate pain of uncertain etiology following an indeterminate MRI or CT
- **Red** – CT with IV contrast, CT without and with IV contrast, MRI with IV contrast, MRI without and with IV contrast, PET, PET/CT, MR arthrography, CT arthrography

Level of Evidence: MRI without contrast, CT without contrast: low-moderate; bone scan, SPECT/CT, MRI without and with contrast, MRI with contrast, MR arthrography, CT arthrography, CT with contrast, CT without and with contrast, PET/CT: insufficient

Notes concerning applicability and/or patient preferences:
*Nuclear medicine studies fused with CT (or MRI) are not yet widely available, and therefore may have applicability or generalizability issues in the community outpatient setting (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
MRI is the best investigation for differential diagnosis of tarsal tunnel syndrome…, plantar fasciitis, tibialis posterior tenosynovitis, or tarsal coalition (Bussieres et al 2007 pg 13).

In patients with *painful rigid flat foot, radiographs unremarkable or equivocal, clinical concern for tarsal coalition* the *American College of Radiology* recommends CT without IV contrast (9) or MRI without IV contrast (9) (Wise et al [*ACR*] 2013** variant 2).

In patients with *chronic ankle pain, ankle radiographs normal, pain of uncertain etiology, next study* the *American College of Radiology* recommends MRI ankle without IV contrast (*usually appropriate*). CT ankle without IV contrast, Tc-99m bone scan with SPECT/CT ankle, image-guided anesthetic injection ankle, or ultrasound ankle *may be appropriate* (Chang et al [*ACR*] 2018 variant 7).

CT or MRI may be appropriate for surgical planning in patients with known coalition (PLE expert panel consensus opinion).

** This guideline did not pass the AGREE II cutoff of 90. It was included, however, because of its direct relevance to the tarsal coalition scenario.

Clinical/imaging notes:
- 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 (Wise et al [*ACR*] 2013).
- In hindfoot-heel pain, radiographs can be used to exclude [bony] tarsal coalition (Bussieres et al 2007).
- Calcaneonavicular [osseous] coalition is easily detected on oblique radiographs of the foot and confirmed by computed tomography (Wise et al [*ACR*] 2013; PLE expert panel consensus opinion).
- Talocalcaneal coalition is frequently overlooked on standard foot radiographs because of overlapping structures (Wise et al [*ACR*] 2013).

- MRI can provide a more sensitive and specific evaluation of the surrounding soft tissues compared to CT (Wise et al [*ACR*] 2013).

Evidence update (December 2014 - present):
No new low, moderate or high level evidence addressing the utility of advanced imaging in this clinical scenario.

Guideline exclusions:

- Inflammatory arthritis (other than septic arthritis)
- Crystal deposition disease
- Metabolic bone disease
- Primary synovial abnormalities (e.g., PVNS, osteochondromatosis)
- Evaluation of indeterminate bone lesion and/or suspected neoplasm on radiograph
- Primary soft tissue neoplasm
- Lisfranc injuries
- CT navigation or modeling for ankle arthroplasty
- Painful ankle or hind foot arthroplasty
- Complex regional pain syndrome (CRPS)
- Pediatric patients
- Pregnant patients