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Hip Pain AUC
2024 update
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Appropriateness of advanced imaging procedures* in patients with hip pain and the following clinical presentations or diagnoses:

*Including MRI, CT, MR arthrography, CT arthrography, bone scan, SPECT and PET

Abbreviation list:

AAOS	American Academy of Orthopaedic Surgeons	MDCT	Multidetector computed tomography
ACR	American College of Radiology	MRI	Magnetic resonance imaging
ANZHFR	Australian and New Zealand Hip Fracture Registry	NICE	National Institute for Health and Care Excellence
APTA	American Physical Therapy Association	OA	Osteoarthritis
		ON	Osteonecrosis
AVN	Avascular necrosis	PD	Proton density
CT	Computed tomography	PET	Positron emission tomography
DOD	Department of Defense	PLE	Provider Led Entity
EULAR	European League Against Rheumatism	SPECT	Single-photon emission computerized tomography
FAI	Femoral acetabular impingement	VA	Department of Veterans Affairs

Appropriate Use Criteria: How to Use this Document

The RAYUS Quality Institute follows the recommendation framework defined by the Appraisal of Guidelines for Research & Evaluation (AGREE II), AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) and a modified version of the QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies) to evaluate the strength of recommendations concerning advanced imaging. Considerations used to determine a recommendation are listed below.

Primary recommendation (green): Strong recommendation for imaging. There is confidence that the desirable effects of imaging outweigh its undesirable effects.

Alternative recommendation (yellow): Conditional recommendation for imaging. The desirable effects of imaging likely outweigh its undesirable effects, although some uncertainty may exist. Alternative imaging recommendations may be indicated with a contraindication to the primary recommendation, in specific clinical scenarios, or when the primary recommendation results are inconclusive or incongruent with the patient's clinical diagnosis. Case-by-case indications to consider have been noted in brackets when appropriate.

Recommendation against imaging (red): The test may not be accurate, may not be reliable, or the undesirable effects of imaging outweigh any desirable effects. Additionally, the recommendation may be impractical or not feasible in the targeted population and/or practice setting(s).

Hip Pain AUC Summary:

- In most instances, **MRI (without IV contrast)** is the initial advanced imaging procedure of choice for hip pain. It is indicated for suspected labral or tendon tears, bursitis, and suspected occult or stress fractures not identified on initial radiographs.
  - The addition of MRI contrast can be helpful for imaging indeterminate or aggressive bone lesions noted on radiographs, or to evaluate equivocal or non-diagnostic findings on recent noncontrast MRI when osteomyelitis or osteonecrosis is suspected.
  - MRI is otherwise generally indicated for patients whose pain and dysfunction persists after four to six weeks of conservative therapy and who have normal or nondiagnostic radiographs.
- **MR arthrography** may increase the sensitivity of MRI for labral tears. It can also be useful in patients with unexplained pain that is unresponsive to conservative therapy. **CT arthrography** is generally reserved for patients unable to undergo MRI.
- **CT arthrography** is generally recommended for further evaluation of non-diagnostic findings on recent noncontrast MRI or for patients who are unable to undergo MRI. CT without contrast is indicated in selected scenarios when surgical planning or evaluation of healing are necessary, or when the patient has increased or equivocal uptake on a previously performed bone scan.
- **Conventional radiographs** are commonly used for the initial evaluation of a suspected fracture, osteoarthritis, or other unexplained pain of suspected hip etiology.
- **Ultrasound** can be useful to assess suspected periarticular tendinopathy, tendon tears, and/or bursitis, particularly when MRI is not available. Its use should be limited to dedicated and trained experts.
- **Bone scan** can be useful for patients with suspected stress or occult fracture, osteonecrosis, or osteomyelitis for evaluating recent findings on noncontrast MRI, or when MRI is not available. Whole body bone scan is indicated whenever metastatic disease is suspected. The addition of SPECT or SPECT/CT, when available, may increase the specificity of a bone scan.

PICO 1: Hip, buttock, or thigh pain with suspected stress, insufficiency, or occult fracture of the hip; radiographs normal or non-diagnostic:

- Green – **MRI hip without IV contrast**
- Yellow – **CT hip without IV contrast** (any of the following)
  - further evaluate non-diagnostic findings on recent* MRI without IV contrast
  - patient unable to undergo MRI
  - patient has increased or equivocal uptake on previous bone scan
  - evaluation of healing is necessary
- Yellow – **Planar bone scan** with or without **SPECT/CT** (either of the following)
  - further evaluate non-diagnostic findings on recent* MRI without IV contrast
  - patient unable to undergo MRI
- Red – **Ultrasound hip**
- Red – **MRI hip without and with IV contrast**
- Red – **MR arthrography** or **CT arthrography**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**
- Red – **Multiphase bone scan**

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

Level of Evidence: MRI: moderate; CT, bone scan, SPECT: low; MR with IV contrast, MR arthrography, CT arthrography, PET: PLE expert panel consensus opinion

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:
Radiography
Radiographs should be the initial imaging study for most suspected abnormalities of the hip and pelvis (*ACR-SPR-SSR Practice Parameter* 2021). Radiographs are relatively insensitive for stress fracture in the early stages of injury; however, if symptoms have been present for 10-14 days, they can achieve sensitivity of 30% to 70%, making them an effective screening tool (Morrison et al [ACR] 2024). If findings on initial radiographs are conclusive for stress fracture, often no further imaging is necessary (Morrison et al [ACR] 2024). A follow-up radiographic examination (10-14 days) has increased sensitivity to initial radiographs but is still less sensitive than MRI (Morrison et al [ACR] 2024).

The diagnosis of hip fracture is easily missed and, in some patients, the fracture may not be apparent on conventional radiographs (*NICE* 2017). Other imaging modalities used to assist in the early detection of occult hip fractures may include MRI, CT, or bone scan, with the type of secondary imaging modality often determined by considerations of access and availability of radiological expertise (*NICE* 2017).

MRI
MRI without IV contrast is reserved for second-line imaging in instances of negative radiographs for both fracture detection and characterization of fracture morphology (Ross et al [*ACR*] 2019). In this scenario,

MRI is generally the investigation of choice (Morrison et al [ACR] 2024; Ross et al [ACR] 2019; *NICE* 2017; *ANZHFR* 2014: consensus-based recommendation), and numerous studies have found MRI to have the highest accuracy (100% sensitivity and 93%-100% specificity) (NICE 2017). MRI demonstrates stress abnormalities as early as bone scintigraphy and with as much sensitivity, and therefore MRI should supersede scintigraphy as the examination of choice (Morrison et al [ACR] 2024). With the diagnostic accuracy of noncontrast MRI approaching 100%, there is little need for addition of IV gadolinium contrast solely for the purposes of stress injuries and fracture detection (Morrison et al [ACR] 2024; Ross et al [*ACR*] 2019).

CT

CT is not typically supported for the initial imaging of suspected stress fractures but may offer an adjunct role when other modalities are equivocal (Morrison et al [ACR] 2024). Although superior to radiography, it is less sensitive than nuclear scintigraphy or MRI (Morrison et al [ACR] 2024). If MRI is not available within 24 hours, or is contraindicated, CT should be considered (*ANZHFR* 2014: consensus-based recommendation; *NICE* 2017). Imaging with IV contrast does not provide added information over noncontrast imaging for stress injuries (Morrison et al [ACR] 2024).

Bone scan

Bone scan is valued for its sensitivity and is often regarded as the reference standard for detecting stress-induced injuries and differentiating between osseous and soft tissue injury (Morrison et al [ACR] 2024). Normal bone scintigraphy generally excludes a diagnosis of stress fracture; however, in elderly or osteoporotic patients, abnormalities may not show up on bone scintigraphy for several days after the injury (Morrison et al [ACR] 2024). Planar scintigraphy combined with SPECT is more accurate in diagnosing stress injuries than planar scintigraphy alone, and shows stress fractures days to weeks earlier than radiographs in many instances (Morrison et al [ACR] 2024). Because bone scintigraphy is often nonspecific, and supplemental imaging is often also required, there is consensus in the literature that cross-sectional imaging should initially supersede bone scintigraphy as the imaging of choice following negative radiographs (Morrison et al [ACR] 2024). In current practice, the role of bone scanning as a secondary line of imaging in patients with contraindications to MRI has largely been usurped by CT (Ross et al [*ACR*] 2019).

<u>Clinical notes:</u>

- Patients at high-risk for fracture include those with osteoporosis, those on bisphosphonate therapy, and athletes. Stress fractures in this population that are not identified in a timely fashion can progress to more serious fractures and complications (Morrison et al [ACR] 2024).
- Pelvic and hip insufficiency fractures have varied presentations (e.g., intractable lower back or pelvic pain, loss of mobility, symptom exacerbation with weight bearing) and often insidious onset (Morrison et al [ACR] 2024).
- Clinical features of stress fractures include exertional anterior hip pain, especially after an increase in training regimen, chronic repetitive overloads in athletes, or reduced mechanical bone properties (athletic amenorrhea, osteoporosis, corticosterioid use) (Bussières et al 2007).
- Clinical features of an osteoporotic femoral neck fracture include age > 65 years, onset before or after a fall, inability to walk, and display of shortening and external rotation (Bussières et al 2007).
- A high index of clinical suspicion for hip fracture is required in patients with a typical history – usually hip pain following trauma – as features such as the inability to bear weight or a shortened, abducted and externally rotated leg may be absent (*NICE* 2017; Bussières et al 2007).

- In patients with insufficiency fractures of the hip, consider dual-energy x-ray absorptiometry (DEXA) to assess for osteoporosis (Bussières et al 2007).

Imaging notes:

- MRI for suspected fracture should include T1 and fluid sensitive sequences (STIR or T2 fat saturation) (PLE expert panel consensus opinion).
- Limited MR protocols (T1 coronal and STIR coronal images of the pelvis/hips) can be used in emergent settings to exclude a hip fracture (PLE expert panel consensus opinion).
- When CT is used, the "as low as reasonably achievable radiation dose" principle should be adhered to (e.g., Mayo-Smith et al 2014).

Evidence update (2016-present):

High Level of Evidence

Haj-Mirzaian et al (2020), in a systematic review and meta-analysis, estimated the frequency of radiographically occult hip fracture in elderly patients and determined diagnostic performance of CT and bone scanning with MRI as the reference standard. Studies were included if patients were clinically suspected to have hip fracture but without radiographic evidence. The pooled rate of occult fracture, diagnostic performance of CT and bone scanning, and strength of evidence (SOE) were assessed. A total of thirty-five studies were identified (n = 2992 patients; mean age, 76.8 years). The frequency of occult fracture was 39% (1110 of 2835 patients; 95% confidence interval [CI]: 35%-43%) in studies of patients with no definite radiographic fracture and 92% (134 of 157 patients; 95% CI: 83%-98%) in studies of patients with radiographic evidence of isolated GT fracture (moderate SOE). CT and bone scanning yielded comparable diagnostic performance in detecting radiographically occult hip fracture (P = .67), with a sensitivity of 79% and 87%, respectively (low SOE). The authors conclude that elderly patients with acute hip pain and negative or equivocal findings on radiography have a high frequency of occult hip fractures. Therefore, the performance of advanced imaging (preferably MRI) may be clinically appropriate in all such patients.

Moderate Level of Evidence

Wilson et al (2020), in a systematic review and meta-analysis, evaluated the diagnostic accuracy of limited MRI protocols for detecting radiographically occult proximal femoral fracture. Articles of radiographically occult proximal femoral fractures compared with multiparametric MRI with or without clinical outcome as the reference standard were included. Eleven studies with 938 patients and 247 proximal femoral fractures met inclusion criteria, and five were included in the meta-analysis. The pooled and weighted summary sensitivity and specificity and the area under the summary ROC curve for limited MRI protocols in detecting radiographically occult hip fractures were 99% (95% CI, 91–100%), 99% (95% CI, 97–100%), and 1 (95% CI, 0.99–1), respectively. The aggregate sensitivity and specificity values for a single-plane T1-weighted sequence only, STIR sequence only, T1-weighted and STIR sequences, and T2-weighted sequence only were as follows: 97% (89/92) and 100% (76/76), 99% (126/127) and 99% (865/873), 100% (118/118) and 99% (867/874), and 86% (51/59) and 97% (137/141), respectively. Sensitivity was 100% (58/58) when images were acquired on 3-T scanners only and 99% (284/288) when interpreted only by certified radiologists. The mean scanning time for limited MRI protocols was less than 5 minutes. The authors conclude that limited protocols can be used as a standard of care in these patients; a protocol of coronal T1-weighted and STIR sequences is 100% sensitive.

Low Level of Evidence

Haims et al (2021) retrospectively evaluated the negative predictive value of CT for occult hip or pelvis fracture in the setting of negative radiographs among elderly patients (n = 237; age > 65) presenting to the emergency department. There were a total of 81 cases with a negative index CT, as determined by 2 musculoskeletal radiologists, and with some form of imaging follow-up (MRI, CT, or radiographs) performed within the following 18 months. A total of eight (9.9%) patients had a fracture on follow-up imaging, with three involving the femoral neck or intertrochanteric femur. The negative predictive value of the index CT was 90.1%, which improved to 96.3% among surgically relevant fracture cases. The authors conclude that while CT for occult hip fracture has a high negative predictive value, there are cases not detected with surgical implications.

PICO 2: Hip pain with suspected labral tear (with or without femoral acetabular impingement syndrome):

- Green – **MRI hip without IV contrast**
- Green – **MR arthrography hip**
- Yellow – **CT arthrography hip**
    - patient unable to undergo MRI
- Yellow – **CT bilateral hips without IV contrast (with 3D reformations)**
    - pre-surgical planning is necessary
- Red – **Ultrasound hip**
- Red – **MRI hip without and with IV contrast**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**
- Red – **Bone scan / SPECT**

Level of Evidence: MRI, MR arthrography: moderate; CT, CT arthrography: low; bone scan, SPECT, PET: PLE expert panel consensus opinion

Notes concerning applicability and/or patient preferences:
Femoral acetabular impingement (FAI) is a clinical syndrome typically seen in younger patients. It is rare for patients over age 65 to present with primary FAI, and MR arthrography may not always be appropriate in this group (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Radiography
Hip and pelvic radiographs are recommended in the literature as the initial choice for imaging in those with acute or chronic hip pain (Enseki et al [APTA] 2023; Jawetz et al [ACR] 2022; ACR-SPR-SSR Practice Parameter 2021). Often a pelvic radiograph, which includes imaging of both hips, may be obtained concurrently with additional dedicated radiographs of the affected hip (Jawetz et al [ACR] 2022). The results of screening radiographs can also help guide the use of additional imaging studies (Jawetz et al [ACR] 2022).

MRI and MR arthrography
Evidence suggests that either MRI without IV contrast or MR arthrography is able to identify labral tears accurately (Enseki et al [APTA] 2023. MR arthrography has been established as a reliable technique for diagnosing acetabular labral tears and is useful for diagnosing acetabular labral tears that are frequently associated with FAI and/or hip dysplasia, with a sensitivity of 94.5% and a specificity of 100% (Jawetz et al [ACR] 2022). It may also better evaluate capsular volume and acetabular chondral delamination (Enseki et al [APTA] 2023). Noncontrast MRI is recommended when extra-articular conditions are suspected to contribute to the patient's symptoms (Enseki et al [APTA] 2023. It is useful in the assessment of labral and cartilage lesions in the setting of hip impingement, and can also be useful in detecting extra-articular impingements (Jawetz et al [ACR] 2022).

CT and CT arthrography
While CT is not helpful in the assessment of articular cartilage or labral status, it is often used for preoperative assessment of bony anatomy in the setting of FAI and hip dysplasia (Jawetz et al [ACR

2022; Enseki et al [APTA] 2023). Volume rendered 3-D reconstructions are useful for quantifying the femoral head/neck morphology and providing a noninvasive assessment of hips at risk of FAI (Jawetz et al [ACR] 2022). The addition of IV contrast does not provide additional benefit (Jawetz et al [ACR] 2022). CT arthrography has been shown by some authors to be sensitive for detection of acetabular labral tears, while others have demonstrated that it is not as effective as other modalities (Jawetz et al [ACR] 2022).

Ultrasound
In general, ultrasound is limited in its use for evaluating osseous structures, and it not as sensitive as other modalities for the detection of labral tears (Jawetz et al [ACR] 2022).

Bone scan
There is no relevant literature to support the use of bone scan in the evaluation of acetabular labral tears and/or suspected hip impingement (Jawetz et al [ACR] 2022).

Clinical notes:

- The term femoroacetabular impingement (FAI) is used when describing morphological variation of the acetabulum and/or femur that results in early contact of the proximal femur and the acetabulum during movement (Enseki et al [APTA] 2023).
- Clinical features of labral tear and femoroacetabular impingement typically include “knife sharp” groin pain, painful giving way syndrome, locking, painful clunk or snapping hip, and painful apprehension and impingement tests (Bussières et al 2007).
- An anteroposterior radiograph of the pelvis and a lateral femoral neck view of the symptomatic hip should initially be performed to obtain an overview of the hips, to identify cam or pincer morphologies, and to identify other causes of hip pain. Where further assessment of hip morphology and associated cartilage and labral lesions is desired, cross-sectional imaging is appropriate (Griffin et al 2016).

Imaging notes:

- Cartilage specific sequences (PD, PD fat saturation or T2 fat saturation) should be part of any MRI or MR arthrography examination of the hip in patients being evaluated for an acetabular tear or femoral acetabular impingement (PLE expert panel consensus opinion).
- The presence of subchondral marrow edema and subchondral cyst has an adverse effect on the prognosis of patients with FAI. Any MRI or MR arthrography obtained for labral tears or femoral acetabular impingement should include a fluid-sensitive sequence (STIR or T2 fat saturation) in the coronal plane (PLE expert panel consensus opinion).

Evidence update (2014-present):
High Level of Evidence
Frank et al (2015), in a systematic review, addressed the incidence of radiographic findings suggestive of FAI in asymptomatic individuals. The prevalence of an asymptomatic cam deformity was 37%-54.8% in athletes, versus 23.1% in the general population. The prevalence of asymptomatic hips with pincer deformity was 67% (range 61%-76% between studies). Only 7 studies reported on labral injury, which was found on MRI without intra-articular contrast in 68% of hips. The authors concluded FAI morphologic features and labral injuries are common in asymptomatic patients.

Moderate Level of Evidence
Chopra et al (2018) compared the diagnostic accuracy of conventional 3T MRI vs. 1.5T MR arthrography

in 68 consecutive patients (median age 32 years) with FAI. All patients underwent both MRI and MR arthrography, and two blinded MSK radiologists scored images for internal derangement, including labral and cartilage abnormality. A total of 39 (57%) patients subsequently underwent hip arthroscopy, and surgical results and radiology findings were analyzed. Results found both readers had higher (but not statistically significant) sensitivities for detecting labral tears with 3T MRI. For acetabular cartilage defect, both readers had higher (statistically significant) sensitivities using 3T MRI (p=0.02). Both readers had a slightly higher (not statistically significant) sensitivity for detecting delamination with 1.5T MR arthrography. The authors conclude that conventional 3T MRI is equivalent to 1.5T MR arthrography in detecting acetabular labral tears and possibly superior to 1.5T MR arthrography in detecting acetabular cartilage defects in patients with suspected FAI. 3T MRI is equivalent to 1.5T MR arthrography for diagnosing cartilage delamination.

Saied et al (2017), in systematic review and meta-analysis, aimed to detect the accuracy of conventional MRI (cMRI), direct MR arthrography and indirect MR arthrography for the diagnosis of chondral and labral lesions in FAI. A total of 21 studies (n = 828 patients; mean age 34 years), using surgical comparison as the reference test, were included, with 12 studies included for meta-analysis. For labral lesions, the pooled sensitivity, specificity and area under the curve (AUC) were 0.864, 0.833, and 0.88 for cMRI and 0.91, 0.58, and 0.92 for direct MR arthrography. In chondral lesions, the pooled sensitivity, specificity and AUC were 0.76, 0.72, and 0.75 for cMRI and 0.75, 0.79, and 0.83 for direct MR arthrography. The sensitivity and specificity for indirect MR arthrography were 0.722 and 0.917. The authors conclude that diagnostic test accuracy of direct MR arthrography was superior to cMRI for detection of labral and chondral lesions. Promising results were found for indirect MR arthrography, but further studies will need to fully assess its diagnostic accuracy.

Reiman et al (2017), in a systematic review and meta-analysis, summarized and evaluated the diagnostic accuracy and clinical utility of various imaging modalities and injection techniques relevant to hip FAI/acetabular labral tear (ALT). A total of 25 articles were included: no studies investigating FAI qualified for meta-analysis; twenty articles on ALT qualified for meta-analysis. Positive imaging findings increased the probability that a labral tear existed by a minimal to small degree with use of MRI/MR arthrography and ultrasound, and by a moderate degree for CT arthrography. Negative imaging findings decreased the probability that a labral tear existed by a minimal degree with use of MRI and ultrasound, a small to moderate degree with MR arthrography, and a moderate degree with CT arthrography. The meta-analysis showed that CT arthrography demonstrated the strongest overall diagnostic accuracy, with pooled sensitivities of 0.91 (95% CI: 0.83-0.96) and pooled specificities of 0.89 (95% CI: 0.74-0.97).

Low Level of Evidence

Froerer et al (2024), in a retrospective study, compared the reliability of MRI and MR arthrography for hip capsular thickness measurement in 85 patients with femoroacetabular impingement syndrome (FAIS). A database of patients with FAIS identified candidates with preoperative MRI or MR arthrography, and two reviewers independently examined preoperative imaging. Capsular thickness was measured in 12 standardized locations. Thirty patients were randomly selected for repeat measurements by 1 reviewer following a washout period. Ten additional patients with preoperative MRI and MRA of the same hip were identified to compare measurements between modalities using paired samples t test. The interclass correlation coefficient (ICC) for measurements on MRI and MR arthrography to compare inter-rater reliability were 0.981 and 0.985. ICCs calculated using measurements by a single reviewer following a washout period for intrarater reliability were 0.998 and 0.991. The authors conclude that for patients with FAIS, both MRI and MR arthrography have excellent reliability for quantifying hip capsular thickness.

Goldsmith et al (2022), in a retrospective study, aimed to correlate MRI and CT femoral version measurements in patients presenting with FAI-related complaints. A total of 58 patients (age 18-35 years old) were included, with all having both CT and MRI of both hips. Femoral version was measured by three reviewers. Femoral version averaged 6.1^{o} +/- 11.8^{o} on CT and 6.5^{o} +/- 10.8^{o} on MRI. A strong positive correlation was reported between the two imaging modalities (r: 0.81; $P < 0.001$). Inter-rater reliability among the three reviewers was excellent and statistically significant for measurements on both MRI [intraclass correlation coefficient (ICC): 0.95; 95% CI: 0.85, 0.99; $P < 0.001$] and CT (ICC: 0.97; 95% CI: 0.92, 0.99; $P < 0.001$). The authors suggest that MRI is a sufficient method for measuring femoral version and physicians should take into account the possible benefits of ordering an MRI over a CT, such as no ionizing radiation and the ability to visualize soft tissues.

Saied et al (2019), in a retrospective study, assessed the reliability of direct MR arthrography and conventional MRI in diagnosing labral lesions in patients with symptoms of femoroacetabular impingement (FAI). Imaging and surgical data were collected from 5 high-volume centers, with a total of 490 patients included. Preoperative imaging findings were compared with actual surgical findings regarding labral condition in order to assess the effectiveness of MRI and MR arthrography. Results found accuracy to be slightly higher for MRI (71.4%) compared to MR arthrography (68.2%), while MR arthrography had higher sensitivity (74.4%,) compared to MRI (66.9%). The authors conclude that MRI and MR arthrography may both be useful for diagnosing acetabular labral lesions.

PICO 3: Hip pain with suspected periarticular tendinopathy, tendon tear, and/or bursitis:

- Green – **MRI hip without IV contrast**
- Green – **Ultrasound hip**
- Yellow – **CT hip without IV contrast**
  - patient unable to undergo MRI and ultrasound expertise is not available
- Red – **MRI hip without and with IV contrast**
- Red – **MR arthrography** or **CT arthrography**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**
- Red – **Bone scan / SPECT**

Level of Evidence: MRI, CT and bone scan: very low; MR arthrography, CT arthrography, PET: PLE expert panel consensus opinion

Notes concerning applicability and/or patient preferences: Where expertise is available, ultrasound has been shown to be accurate in the evaluation of periarticular tendons and bursitis of the hip (Jawetz et al [ACR] 2022; PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:

Radiography

The literature indicates that radiography is a first-line screening tool, and hip radiographs are useful in the initial imaging workup of acute or chronic hip pain (Jawetz et al [ACR] 2022; *ACR-SPR-SSR Practice Parameter* 2021). Often a pelvic radiograph, which includes imaging of both hips, may be obtained concurrently with additional dedicated radiographs of the affected hip (Jawetz et al [ACR] 2022). The results of screening radiographs can help guide the use of additional imaging studies (Jawetz et al [ACR] 2022).

MRI

MRI without IV contrast is both highly sensitive and specific for evaluation of the articular and periarticular soft tissues and should be considered as the next imaging test following radiographic evaluation of the hip joint (Jawetz et al [ACR] 2022). This includes suspected diagnoses of strain, tendinitis, tendinosis, or other abnormalities involving the surrounding soft tissue of the hip (Bussières et al 2007: grade D recommendation). Trochanteric, iliopsoas, ischial, and subiliacus bursitis are well demonstrated on noncontrast MRI, as are abductor and adductor tendinosis and tears, hamstring injuries, athletic pubalgia, and calcific tendinosis (Jawetz et al [ACR] 2022). There is no relevant literature to support the use of MR arthrography in the evaluation of extra-articular soft tissue pathology (Jawetz et al [ACR] 2022).

Ultrasound

In nontraumatic trochanteric and iliopsoas bursitis, ultrasound is an easy-to-perform and fast alternative to MRI (Bussieres et al 2007). Ultrasound is useful for the evaluation of extra-articular soft tissues in the region of the hip and can nicely demonstrate fluid collections such as bursitis and paralabral cysts. Tendon pathology, such as tendinosis, tears, or snapping iliopsoas tendons can also be identified (Jawetz et al [ACR] 2022).

CT

CT without IV contrast is of limited use in the evaluation of extra-articular soft tissue pathology, however, pathology such as a large, distended bursa may be evident on CT (Jawetz et al [ACR] 2022). As CT is less sensitive than MRI or ultrasound for evaluation of soft tissue, its role may be limited to patients who are unable to undergo MRI and when ultrasound expertise is also not available (PLE expert panel consensus opinion).

Evidence update (2015-present): No articles identified in the 2024 update that have impact on the guideline summary and recommendations listed above.

PICO 4: Osteoarthritis of the hip on conventional radiography with any of the following

- **New-onset severe pain**
- **Significant change in symptoms**
- **Pain that is disproportionate to findings on repeat radiography**
- **Pre-surgical planning is necessary:**

- Green – **MRI hip without IV contrast**
- Yellow – **CT hip without IV contrast**
    - patient unable to undergo MRI
- Yellow – **CT arthrography hip**
    - patient unable to undergo MRI
- Red – **Bone scan** with or without **SPECT/CT**
- Red – **Ultrasound hip**
- Red – **MRI hip without and with IV contrast**
- Red – **MR arthrography**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**

Level of Evidence: MRI: moderate; CT, CT arthrography, bone scan: low; MRI with IV contrast, MR arthrography, SPECT, PET: PLE expert panel consensus opinion

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:
Imaging should not routinely be used to diagnose osteoarthritis unless there are atypical features or features that suggest an alternative or additional diagnosis (NICE 2022; Sakellariou et al [*EULAR*] 2017: Level of Evidence III-IV). Atypical features could include a history of recent trauma, prolonged morning joint-related stiffness, rapid worsening of symptoms or deformity, the presence of a hot swollen joint, or concerns that may suggest infection or malignancy (NICE 2022). Imaging is also recommended if there is unexpected rapid progression of symptoms or change in clinical characteristics to determine if this relates to osteoarthritis or an additional diagnosis (Sakellariou et al [*EULAR*] 2017: Level of Evidence III-IV).

Radiography
Radiography is the most often used method when diagnosing and assessing the progression of hip osteoarthritis (Sakellariou et al [EULAR] 2017; Jawetz et al [ACR] 2022; *ACR-SPR-SSR Practice Parameter* 2021; Bussieres et al 2007). Radiographs are used to look for joint space narrowing, the presence of osteophytes, and subchondral sclerosis or cysts (Cibulka et al [APTA] 2017). The literature indicates that radiography is a first-line screening tool, and hip radiographs are useful in the initial imaging workup of chronic hip pain (Jawetz et al [ACR] 2022).

MRI
In general, the *VA/DOD* suggests against obtaining magnetic resonance imaging for the diagnosis of osteoarthritis of the hip (*VA/DOD* 2020: "weak against" recommendation). However, some surgeons may elect to obtain MRI occasionally to answer specific clinical or surgical questions on a case-by-case basis (*VA/DOD* 2020). Direct visualization of articular cartilage is possible on MRI because of its intrinsic excellent soft tissue contrast resolution (Jawetz et al [ACR] 2022). Delayed gadolinium-enhanced MRI of cartilage, while potentially helpful to assess the degree of hip cartilage damage, is a technique that is not often used clinically (Jawetz et al [ACR] 2022).

CT
In general, CT is not supported for assessing extent of cartilage damage in those with chronic hip pain, due to its inherent poor soft tissue contrast resolution (Jawetz et al [ACR] 2022). However, it may be utilized for preoperative assessment (Jawetz et al [ACR] 2022).

CT arthrography
Intra-articular administration of contrast can also help with the direct visualization of articular cartilage (Jawetz et al [ACR] 2022). Hip cartilage abnormalities can be successfully evaluated by high-resolution CT arthrography, allowing for improved assessment of degree of cartilage loss when compared with initial radiographs (Jawetz et al [ACR] 2022).

Bone scan
There is no relevant literature to support the use of bone scan for assessing the extent of cartilage damage in a patient with chronic hip pain (Jawetz et al [ACR] 2022).

Ultrasound
Ultrasound is generally limited in its ability to evaluate the acetabular or much of the femoral head cartilage (Jawetz et al [ACR] 2022).

<u>Clinical notes:</u>

- Imaging abnormalities of osteoarthritis are commonly seen, especially with increasing age (Sakellariou et al [EULAR] 2017).
- Osteoarthritis can often be diagnosed clinically without imaging in people who: are age 45 or over, have activity-related joint pain, and have either no morning joint-related stiffness or morning stiffness lasting no more than 30 minutes (NICE 2022).
- Clinicians must distinguish symptomatic osteoarthritis from other entities that can cause hip pain, including inflammatory (e.g., rheumatoid and psoriatic) arthritis, infectious and crystalline (e.g., gout, pseudogout) arthritis, and soft tissue lesions (Katz et al 2021).
- Hip radiographs typically include an anteroposterior view and a lateral view. Weight bearing is not necessary. The interrater and intrarater reliabilities of hip radiographs for detecting joint space narrowing are high (Katz et al 2021).

<u>Evidence update (2013-present):</u>
Low Level of Evidence
Crim et al (2019), in a retrospective study, assessed the concordance of radiographic assessment of osteoarthritis severity with findings of gross and microscopic evaluation analysis in the preoperative assessment for hip arthroplasty. Radiology and pathology reports from 953 consecutive femoral head resections were reviewed to establish correlation of findings. In 83 cases, MRI images were also available for review. Both radiologists and pathologists prospectively used a four-grade scale of absent,

mild, moderate, or severe osteoarthritis. Radiographs showed severe osteoarthritis in 62.3% of patients, moderate in 20%, and no/mild in 17.7%. Observed agreement between radiology and pathology findings was 90%. There were significant discrepancies between radiography grade and pathology grade in 2.2% of cases. Observed agreement between radiography and MRI was 78%. The authors conclude that radiography findings are a reliable indicator of severity of osteoarthritis.

PICO 5: Unexplained pain (hip, groin, buttock, thigh, knee) of suspected hip etiology that is unresponsive to 4-6 weeks of conservative therapy; radiographs normal or nondiagnostic:

- Green – **MRI hip without IV contrast**
- Yellow – **MR arthrography hip**
- Yellow – **CT arthrography hip**
    - patient unable to undergo MRI
- Yellow – **Planar bone scan** with or without **SPECT/CT** (either of the following)
    - further evaluate non-diagnostic findings on recent* MRI without IV contrast
    - patient unable to undergo MRI
- Yellow – **CT hip without IV contrast** (any of the following)
    - patient unable to undergo MRI
    - pre-surgical planning is necessary
    - patient has increased or equivocal uptake on previous bone scan
- Yellow – **Ultrasound hip**
- Red – **MRI hip without and with IV contrast**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**
- Red – **Multiphase bone scan**

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

Level of Evidence: MRI, MR arthrography: very low; CT, CT arthrography, bone scan, SPECT, PET: PLE expert panel consensus opinion

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:
Radiography
The literature indicates that radiography is a first-line screening tool, and hip radiographs are useful in the initial imaging workup of chronic hip pain (Jawetz et al [ACR] 2022; *ACR-SPR-SSR Practice Parameter* 2021). Often a pelvic radiograph, which includes imaging of both hips, may be obtained concurrently with additional dedicated radiographs of the affected hip (Jawetz et al [ACR] 2022). The results of screening radiographs can help guide the use of additional imaging studies (Jawetz et al [ACR] 2022).

MRI and MR arthrography
In the setting of chronic hip pain with negative or nondiagnostic radiographs, MRI hip without IV contrast is usually appropriate as the next imaging study (Jawetz et al [ACR] 2022). It is typically the most appropriate modality to exclude the hip as a source of pain in patients presenting with chronic hip pain and low back, pelvic, or knee pathology (Jawetz et al [ACR] 2022). It is also useful for evaluating soft tissues given its high soft tissue contrast resolution (Jawetz et al [ACR] 2022). In this population, MR arthrography may also be considered, particularly for suspected impingement or labral tear, or to better assess articular cartilage integrity (Jawetz et al [ACR] 2022; Bussières et al 2007: grade D

recommendation).

Ultrasound
In the setting of chronic hip pain with negative or nondiagnostic radiographs, ultrasound of the hip can be helpful, particularly if there is a suspected noninfectious extra-articular abnormality, such as tendonitis, bursitis, or infection (Jawetz et al [ACR] 2022; Ha et al [ACR] 2022).

CT
CT may offer an adjunct role when other modalities are equivocal, particularly when fracture is suspected (Morrison et al [ACR] 2024). CT can also be useful to assess osseous architecture of the hip and assist with pre-surgical planning (Jawetz et al [ACR] 2022).).

Bone scan
Bone scan can detect stress-induced injuries and differentiates between osseous and soft tissue injury (Morrison et al [ACR] 2024). It can be useful to evaluate for non-articular causes of severe hip pain in patients who cannot undergo MRI, and can also be considered if better localization of symptoms is necessary (PLE expert panel consensus opinion).

Clinical notes:
- Chronic hip pain is a common chief complaint, reportedly affecting 12%-15% of all adults over the age of 60 (Jawetz et al [ACR] 2022).
- Pain in the hip region can originate from non-musculoskeletal, lumbosacral spine, intra-articular, and extra-articular sources (Enseki et al [APTA] 2023). Pathology involving the lumbar spine, sacroiliac, or knee joints can also cause hip pain and these etiologies should be investigated as needed (Jawetz et al [ACR] 2022).

Imaging notes:
- MRI protocol of an ipsilateral hip should include two sequences of the entire bony pelvis to include T1 and water sensitive sequences (STIR or T2 fat saturation) (PLE expert panel consensus opinion).

Evidence update (2014s-present):
Low Level of Evidence
Keeney et al (2014), in a retrospective study, evaluated several parameters including the clinical indications that most commonly influence treatment decisions and likelihood that hip MRI influences treatment decisions separate from conventional radiographs. The authors concluded that although MRI can be valuable for diagnosing or staging specific conditions, it is not cost-effective as a screening tool for hip pain that is not supported by history, clinical examination, and conventional radiographic findings in patients between 40 and 80 years of age.

Neiman et al (2016), in a retrospective study, evaluated the prevalence of non-suspected pathologies revealed by hip MR arthrography in 229 patients (mean age 36.5; age range 18-67 years). The authors reported significant non-targeted pathologies in 76/229 (33%) MR arthrography, including athletic pubalgia, sacroiliitis, fractures, and muscle/tendon abnormalities. Physical examination/pain level could not differentiate between patients with and without non-suspected pathologies.

PICO 6: Hip pain with suspected avascular necrosis (osteonecrosis):

- Green – **MRI hip without IV contrast**
- Yellow –**MRI hip without and with IV contrast**
- Yellow – **CT bilateral hips without IV contrast** (either of the following)
    - patient unable to undergo MRI
    - pre-surgical planning is necessary
- Red – **Ultrasound hip**
- Red – **Bone scan** with or without **SPECT/CT**
- Red – **MR arthrography** or **CT arthrography**
- Red – **CT hip with IV contrast** or **CT hip without and with IV contrast**
- Red – **PET**

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

Level of Evidence: MRI: moderate; CT, bone scan, SPECT: low; MR arthrography, CT arthrography, PET: PLE expert panel consensus opinion

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:
Radiography
In patients with hip pain who are at risk for avascular necrosis, radiographs should be the initial imaging examination (Ha et al [ACR] 2022). Although they are less sensitive, radiographs help to exclude other causes of pain such as fracture, arthritis, or tumor (Ha et al [ACR] 2022).

MRI
MRI without IV contrast is the most sensitive and specific modality for diagnosing osteonecrosis, with sensitivity and specificity nearing 100% (Ha et al [ACR] 2022; Bussières et al 2007: grade B recommendation). MRI allows for characterizing the osteonecrosis including its location, volume, and presence of associated bone marrow edema or joint effusion (Ha et al [ACR] 2022). MRI with contrast enhancement has also been shown to differentiate osteonecrosis from transient bone marrow edema syndrome and subchondral insufficiency fracture (Ha et al [ACR] 2022; PLE expert panel consensus opinion).

CT
CT (without IV contrast) is less sensitive than MRI for detecting early osteonecrosis (Ha et al [ACR] 2022). However, once an insufficiency fracture occurs, CT is superior to MRI in showing location and extent of articular collapse (Ha et al [ACR] 2022). Therefore, CT plays a critical role in surgical planning (Ha et al [ACR] 2022). When MRI is unavailable or the patient is unable to undergo MRI, CT can be used (Bussières et al 2007).

Bone scan
Radionucleotide scintigraphy is not commonly performed for detection of osteonecrosis (Ha et al [ACR] 2022). Bone scanning has largely been replaced by MRI for detecting and characterizing osteonecrosis due to poor spatial resolution and low specificity (Ha et al [ACR] 2022). The addition of SPECT may improve the accuracy of bone scanning, but its use has not been widely accepted (Ha et al [ACR] 2022).

PET
Early limited data on PET/CT have not been shown to be useful in diagnosing early osteonecrosis (Ha et al [ACR] 2022).

<u>Clinical notes:</u>

- Clinical features of osteonecrosis typically include progressive groin pain that may refer to the knee, normal range of motion in early stages, limitation of extension, internal rotation and abduction, limping and atrophy in advanced stages (Bussières et al 2007).
- Risk factors for osteonecrosis are numerous, including trauma, corticosteroid therapy, alcohol use, HIV, lymphoma/leukemia, chemotherapy, and radiation therapy (Ha et al [ACR] 2022).
- In nontraumatic cases, femoral head osteonecrosis is often bilateral (70%-80%) (Ha et al [ACR] 2022).

<u>Imaging notes:</u>

- If avascular necrosis is detected on a unilateral hip exam, then the contralateral hip should also be imaged to screen for asymptomatic avascular necrosis (PLE expert panel consensus opinion).
- In patients who are at high risk for avascular necrosis, consider T1 coronal images and fluid sensitive sequences (STIR or T2 fat saturation) through the pelvis, including both hips, to evaluate for asymptomatic avascular necrosis in the contralateral hip (PLE expert panel consensus opinion).

<u>Evidence update (2014-present):</u>
Low Level of Evidence
Hu et al (2015), in a study of 30 femoral head specimens collected from 23 patients, reported that there was a high correlation between MRI, CT, and coronal sectional gross specimens on the location, shape and size of avascular lesions. CT was superior to MRI, however, in identifying subchondral fracture.

PICO 7: Hip pain with suspicion for septic arthritis, osteomyelitis, and/or periarticular abscess:

- Green – **MRI hip without IV contrast** or **MRI hip without and with IV contrast**
- Yellow – **CT hip with IV contrast** or **CT hip without IV contrast**
  - patient unable to undergo MRI
- Yellow – **Multiphase bone scan** with or without **SPECT/CT**
- Yellow – **White Blood Cell (WBC) scan** with or without **SPECT/CT**
  - patient unable to undergo MRI
- Yellow – **FDG-PET/CT**
  - patient unable to undergo MRI AND other modalities are equivocal
- Yellow – **Ultrasound hip**
- Red – **CT without and with IV contrast**
- Red – **MR arthrography** or **CT arthrography**
- Red – **Planar bone scan**

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

Level of Evidence: MRI, CT, bone scan: very low; MR arthrography, CT arthrography, PET: PLE expert panel consensus opinion

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:

Radiography

The literature indicates that radiographs should be the initial modality used for musculoskeletal infections (Pierce et al [ACR] 2022). Obtaining initial radiographs provides an excellent overview of the anatomic area of interest, can exclude fractures and tumors as the cause of swelling or pain, and assists in the interpretation of future imaging studies (Pierce et al [ACR] 2022).

MRI

With excellent spatial and contrast resolution, MRI can detect and evaluate the extent of both superficial and deep soft tissue infection (Pierce et al [ACR] 2022). Noncontrast MRI is highly accurate for detecting acute osteomyelitis, with high sensitivity and specificity (Pierce et al [ACR] 2022). The addition of IV contrast is useful in patients with septic arthritis and/or osteomyelitis to evaluate for periarticular abscess on MRI or CT (PLE expert panel consensus opinion). Contrast-enhanced MRI further increases the diagnostic sensitivity for abscesses, fistulas, and vascular complications (Pierce et al [ACR] 2022). While the use of IV contrast does not improve diagnosis of peripheral osteomyelitis, it may improve the evaluation of soft tissue infections (Pierce et al [ACR] 2022).

CT

While CT is rather insensitive for evaluating acute osteomyelitis, it can evaluate various soft tissue compartments and help to differentiate cellulitis, myositis, abscess, and septic arthritis (Pierce et al

[ACR] 2022). CT is also superior to MRI in evaluating soft tissue gas (Pierce et al [ACR] 2022). CT with IV contrast can be useful to assess soft tissue and extent of infection (Pierce et al [ACR] 2022). There is no added benefit for multiphase CT imaging before and after IV contrast administration in the evaluation of infection (Pierce et al [ACR] 2022).

Bone scan
Compared to ultrasound, CT, and MRI, bone scan has poor spatial resolution and lacks specificity; however, it can be useful for evaluating multifocal infections (Pierce et al [ACR] 2022). While a multiphase bone scan can be used to rule out osteomyelitis, a positive scan is nonspecific (Pierce et al [ACR] 2022). Therefore, if a multiphase bone scan is positive, also obtaining a WBC scan may increase specificity for the evaluation of acute osteomyelitis (Pierce et al [ACR] 2022). The WBC scan may be particularly helpful in the setting of recent surgery or fracture at the site of infection (Pierce et al [ACR] 2022). Further addition of a sulfur colloid scan may be considered if results remain equivocal (Pierce et al [ACR] 2022). Addition of SPECT/CT may be helpful in localizing acute osteomyelitis (Pierce et al [ACR] 2022).

PET
FDG-PET/CT has both high sensitivity (81%-100%) and specificity (87%-100%) for detecting osteomyelitis, and PET imaging allows for more precise localization compared to other single-photon techniques (Pierce et al [ACR] 2022). However, recent fracture or orthopedic implant may lower FDG-PET's accuracy (Pierce et al [ACR] 2022).

Ultrasound
Ultrasound is of limited benefit in diagnosing osteomyelitis (Pierce et al [ACR] 2022). However, following initial radiographs, ultrasound can be useful for detecting fluid, including joint effusions, abscesses, and infected tendon sheaths (Pierce et al [ACR] 2022). For deeper soft tissue structures and evaluation of adjacent bone involvement, ultrasound is limited compared with MRI or CT (Pierce et al [ACR] 2022).

Clinical notes:

- Even when infection is clinically apparent, imaging can provide additional information, such as extent of infection into deeper tissues, presence of abscesses, joint involvement, and vascular complications (Pierce et al [ACR] 2022).
- Clinical features of septic arthritis of the hip typically include significant pain on movement and weight bearing, fever, and malaise (Bussières et al 2007).
- WBC, ESR and CRP should be considered in patients with a high clinical suspicion for septic arthritis (PLE expert panel consensus opinion). In patients with hip pain and elevated inflammatory markers, consider ultrasound (if appropriate expertise available) to evaluate for an effusion and for joint aspiration (PLE multidisciplinary committee opinion).
- The procedure of choice for suspected infection is joint aspiration, which can be performed under fluoroscopy or ultrasound (Bussières et al 2007; PLE expert panel consensus opinion).
- In patients with proven septic arthritis, MRI shows effusions, synovial enhancement and synovial thickening in all patients, abscesses in 38%, bone marrow edema in 77%, erosions in 62% and myositis/cellulitis in 77%. MR is also useful to follow patients during treatment to assess resolution of effusions and abscesses (Bierry et al 2012).

Evidence update (2014-present):
Low Level of Evidence
Keeney et al (2014), in a retrospective study of 213 patients (218 consecutive hip MRI studies),

evaluated a number of parameters including the clinical indications that most commonly influence treatment decisions and the likelihood that hip MRI influences treatment decisions separate from conventional radiographs. The authors concluded that although MRI can be valuable for diagnosing or staging specific conditions, it is not cost-effective as a screening tool for hip pain that is not supported by history, clinical examination, and conventional radiographic findings in patients between 40 and 80 years of age. MR of the hip affected treatment decisions in 40% of patients undergoing assessment for infection.

PICO 8: Hip pain with suspected indeterminate or aggressive bone lesion following radiographs:

- Green – **MRI hip without IV contrast** or **MRI hip without and with IV contrast**
- Yellow – **CT hip without IV contrast** or **CT hip without and with IV contrast**
- Yellow – **PET** or **PET/CT**
  - further evaluate possible metastatic lesion(s)
- Yellow – **Whole-body bone scan** with or without **SPECT/CT**
  - further evaluate possible metastatic lesion(s)
- Red – **Ultrasound hip**
- Red – **MR arthrography** or **CT arthrography**
- Red – **CT hip with IV contrast**
- Red – **Multiphase bone scan**

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

Level of Evidence: MRI, CT: very low; PET/CT moderate level of evidence; MR arthrography, CT arthrography: PLE expert panel consensus opinion

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:

Radiography

Radiographs are usually appropriate for the initial imaging of a suspected primary bone tumor (Bestic et al [*ACR*] 2020; ACR-SPR-SSR Practice Parameter 2021). They can effectively provide information regarding tumor location, size, and shape, as well as evidence of tumor biological activity (Bestic et al [ACR] 2020).

MRI

MRI without IV contrast or MRI without and with IV contrast is indicated for a suspected primary bone tumor but negative radiographs (Bestic et al [*ACR*] 2020). In addition to detection of occult bone tumors, MRI can identify other radiographically occult abnormalities, such as osseous contusion, developing stress fracture, infection, or regional soft-tissue injury that may account for the patient's symptoms (Bestic et al [ACR] 2020). A noncontrast MRI can also be useful for imaging of a suspected primary bone tumor when radiographs show indeterminate or aggressive appearing lesions suggestive for malignancy (Bestic et al [*ACR*] 2020). MRI is not routinely used in the evaluation of lesions that are benign on radiographs; however, if such lesions are symptomatic, MRI may also be helpful to identify unusual complications, such as stress fracture, secondary aneurysmal bone cyst formation, or malignant transformation (Bestic et al [*ACR*] 2020).

CT

While not routinely used for evaluation of lesions that are benign on radiographs, if such lesions are symptomatic, CT without IV contrast may be useful to identify complications or for surgical planning

(Bestic et al [ACR] 2020). In cases in which radiographs are negative or fail to adequately explain symptoms, CT can be a helpful tool in facilitating detection of bony abnormalities, such as nondisplaced fractures, subtle periosteal reaction, or occult bone tumors (Bestic et al [ACR] 2020). This is particularly true in those patients who are unable to undergo MRI (Bestic et al [ACR] 2020). It can also be especially helpful in evaluating regions of complex or overlapping osseous anatomy, in which radiographic evaluation can be limited (Bestic et al [ACR] 2020).

PET

FDG-PET/CT is not routinely used for evaluating primary bone tumors in patients with positive localized or regional symptoms and negative radiographs, or findings that do not explain symptoms (Bestic et al [ACR] 2020). However, FDG-PET is a valuable adjunct to conventional imaging in the diagnosis, staging, restaging, and surveillance of primary bone tumors (Bestic et al [*ACR*] 2020). It has proven useful for further characterizing indeterminate bone tumors identified on radiographs, has been shown to be accurate in the differentiation of benign from malignant cartilaginous lesions and can differentiate benign from malignant pathologic fractures (Bestic et al [*ACR*] 2020). The sensitivity and specificity of PET/CT for osseous and soft tissue sarcoma is 0.96 and 0.95 respectively (Muheremu et al 2017).

Bone scan/SPECT

Despite its historical utility in detecting radiographically occult bone abnormalities, more recent studies have shown that MRI is superior to bone scan in this role (Bestic et al [ACR] 2020). Its use, therefore, may be limited to select cases in which MRI is not clinically feasible as well as cases that require evaluation of the full extent and distribution of disease (Bestic et al [ACR] 2020). Whole body bone scanning can also be useful to distinguish between a solitary bone lesion and multiple metastatic lesions (PLE expert panel consensus opinion). Recent advances in SPECT/CT may provide a useful tool in the evaluation of primary bone tumors (Bestic et al [*ACR*] 2020).

<u>Clinical notes:</u>

- Bone tumors – both malignant and benign – may be identified as part of the initial diagnostic evaluation of a patient presenting with chronic hip pain (Jawetz et al [ACR] 2022).
- The term "bone tumor" may be applied to a broad range of entities, including tumor-like lesions related to developmental, metabolic, hematopoietic, lymphatic, or reactive abnormalities that affect bone (Bestic et al [*ACR*] 2020).In patients with lesions that are clearly benign on conventional radiographs (bone cyst, nonossifying fibroma, fibrous dysplasia, bone island, fibrocortical defect, etc.), consider follow-up radiograph in 6 months to ensure stability (PLE expert panel consensus opinion).

<u>Imaging notes:</u>

- If the patient is undergoing MRI evaluation, T1 and fluid-sensitive sequences (STIR, T2 fat saturation or PD fat saturation sequences) should be obtained through the entire bony pelvis for acetabular bone lesions and the entire femur for proximal femoral lesions in at least one plane (PLE expert panel consensus opinion).

<u>Evidence update (2007-present)</u>:

High Level of Evidence

Muheremu et al (2017), in a systematic review and meta-analysis, evaluated 16 articles with 883 patients and 2,214 lesions. Nine studies with 738 patients and 2,069 lesions reported the diagnostic accuracy of PET/CT for osseous and soft tissue sarcomas. On a lesion-based analysis, the overall sensitivity and specificity were 0.96 and 0.95. They concluded that PET/CT is a reliable method with high accuracy for the diagnosis of bone and soft tissue sarcomas, although the present findings require verification by larger-sample studies. The authors reported similar results with respect to the accuracy of PET/CT to assess the effect of neoadjuvant therapy on osseous and soft tissue sarcomas.

Yang et al (2011), in a meta-analysis, compared 18F FDG PET, CT, MRI and bone scintigraphy for the diagnosis of bone metastases. 67 articles consisting of 145 studies fulfilled the inclusion criteria. On a per-lesion basis, the pooled sensitivities for PET, CT, MRI and bone scintigraphy were 86.9%, 77.1%, 90.4% and 75.1%. The specificities were 97%, 83.2%, 96% and 93.6% respectively. The authors concluded that PET and MRI were comparable and both were significantly more accurate than CT and bone scintigraphy for the diagnosis of bone metastases.

Low Level of Evidence
O'Sullivan et al (2015), in a review paper, state that MRI is the imaging modality of choice for assessing metastatic spread in the marrow cavity, extension of tumor from the marrow cavity, and involvement of surrounding structures. The sensitivity and specificity of MRI for bone metastases is 95% and 90% respectively, CT 74% and 56%, planar bone scintigraphy 78% and 48%, and SPECT 87% and 91% respectively. 18F NaF-PET is substantially more sensitive and specific than scintigraphy and SPECT for the detection of skeletal metastases, and has a higher sensitivity than 18F FDG-PET. The sensitivity and specificity of 18F NaF-PET/CT for the detection of bone metastases is 100% and 97%.

Guideline exclusions:

- Inflammatory arthritis, other than septic arthritis
- Crystal deposition disease
- Metabolic bone disease
- Primary synovial abnormalities such as pigmented villonodular synovitis (PVNS) or osteochondromatosis
- Primary soft tissue neoplasm
- Athletic pubalgia/sports hernia
- CT navigation or modeling for hip arthroplasty
- Painful hip arthroplasty
- High energy trauma
- Pediatric patients
- Pregnant patients
- Advanced MRI imaging sequences, including diffusion sequences, T2 mapping, T1rho, dGEMRIC, sodium imaging

AUC Revision History:

Revision Date:	New AUC Clinical Scenario(s):	Approved By:
11/07/2017	Initial Document Development	CDI Quality Institute's Multidisciplinary Committee
12/04/2018	n/a	CDI Quality Institute's Multidisciplinary Committee
11/19/2019	n/a	CDI Quality Institute's Multidisciplinary Committee
12/01/2020	n/a	CDI Quality Institute's Multidisciplinary Committee
02/22/2022	n/a	RAYUS Quality Institute's Multidisciplinary Committee
08/20/2024	n/a	RAYUS Quality Institute's Multidisciplinary Committee

Information on our evidence development process, including our conflicts of interest policy is available on our website at **https://rayusradiology.com/ple**

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Hip Pain AUC

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08/20/2024

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