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Hip Pain AUC: 2018 update

12/04/2018

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

Hip, buttock or thigh pain with suspected stress (fatigue), fragility (insufficiency), or occult fracture of the hip and normal or indeterminate radiographs:

- **Green** – MRI hip without IV contrast
- **Yellow** – CT hip without IV contrast in patients with equivocal MRI findings, for patients unable to undergo MRI, with increased or equivocal uptake on bone scan, or to evaluate healing
- **Yellow** – Bone scan or bone scan with SPECT in patients with equivocal MRI findings or for patients who are unable to undergo MRI
- **Red** – MRI hip with IV contrast; MR arthrography; CT hip with IV contrast; CT arthrography; PET

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: none

Guideline and PLE expert panel consensus opinion summary:
Moderate evidence supports MRI as the advanced imaging [exam] of choice for diagnosis of presumed hip fracture not apparent on initial radiographs (*American Academy of Orthopaedic Surgeons* [*AAOS*] 2014, moderate recommendation).

Magnetic resonance imaging (MRI) is recommended if hip fracture is suspected despite negative anteroposterior pelvis and lateral hip x-rays. If MRI is not available within 24 hours, or is contraindicated, consider computed tomography (CT) (*Australian and New Zealand Hip Fracture Registry* [*ANZHFR*] 2014, consensus-based recommendation).

Offer magnetic resonance imaging (MRI) if hip fracture is suspected despite negative x-rays of the hip of an adequate standard. If MRI is not available within 24 hours, or is contraindicated, consider computed tomography (CT) (*National Institute for Health and Care Excellence* [*NICE*] 2017).

MR imaging is the investigation of choice when there is doubt regarding the diagnosis. If MR is not available or not feasible, a radioisotope bone scan or repeat plain radiographs *(after a delay of 24-48 hours)* should be performed (*Scottish Intercollegiate Guidelines Network* [*SIGN*] 2009, grade D recommendation).

Bone scanning is very sensitive for stress reactions, however, is nonspecific and supplemental imaging may be required in areas of abnormal uptake to obtain a diagnosis and to avoid false positives. SPECT imaging is more accurate in diagnosing stress injuries than planar scintigraphy alone (Bencardino et al. *American College of Radiology [ACR]* 2016*).

Limited, small studies have examined the use of CT scan in the diagnosis of occult hip fractures. Due to the quality of existing literature, as well as potential harm with radiation exposure related to use of CT in this setting, this modality was not recommended for evaluation of occult hip fracture (*AAOS* 2014).

CT is not typically used as a first or second line modality because of its decreased sensitivity, but may play an adjunctive role when other modalities are equivocal (Bencardino et al. [*ACR*] 2016*).

Other imaging modalities used to assist in the early detection of occult hip fractures include computed tomography (CT), radionuclide scan (RNS), and, rarely, ultrasound scanning (US). The type of secondary imaging modalities used locally is often determined by considerations of access, particularly outside normal working hours, and radiological expertise available (*NICE* 2017).

If radiographs are inconclusive for stress fractures, re-radiograph after 10-14 days of restricted use before going to advanced imaging. Advanced imaging techniques include bone scan, MRI, or CT in suspected occult, osteoporotic, or stress fractures (Bussières et al., 2007, grade D recommendation). This recommendation may no longer apply as some stress fractures of the hip are high risk, and delays in diagnosis may increase the risk of nonunion, delayed union, displacement and avascular necrosis (Bencardino et al. [*ACR*] 2016*; PLE expert panel consensus opinion).

If radiographs are inconclusive for osteoporotic femoral neck fractures, consider MRI, CT or nuclear medicine study (Bussières et al. 2007, grade D recommendation).

The *American College of Radiology* [suspected stress (fatigue) fracture hip guideline] recommends MRI hip without IV contrast (9), Tc-99m bone scan whole body with SPECT hip (6), X-ray hip repeat in 10-14 days (5), and CT hip without IV contrast (5) in patients with negative radiographs (Bencardino et al. [*ACR*] 2016*). This guideline states that because of the high risk of complications, it is not advisable to wait 10–14 days for a repeat x-ray in the hip. It also states that CT may be useful if MRI cannot be performed.

The *American College of Radiology* [suspected stress (insufficiency) fracture, pelvis or hip guideline] recommends MRI without IV contrast (9), CT without IV contrast (7), and Tc-99m bone scan whole body with SPECT (6) in patients with negative radiographs (Bencardino et al. [*ACR*] 2016*).

* The ACR Guideline by Bencardino et al (2016) did not pass the AGREE II cutoff, but was included because of its direct relevance to the stress fracture clinical scenario.

Clinical notes:

- "Hip" fractures refer to fractures of the proximal femur, acetabulum, and ischiopubic ring (PLE expert panel consensus opinion).
- Clinical features of stress (fatigue and insufficiency) fractures include exertional anterior hip pain, especially after an increase in training regimen, chronic repetitive overloads (typically 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 of hip fracture is required in patients with a typical history – usually hip pain following trauma – as typical 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).
- Emergency referral to secondary care includes hip pain … [with] sudden inability to bear any weight and history of a fall (*British Orthopaedic Association* [*BOA*] 2014).
- Conventional radiography is the initial study of choice for patients with suspected insufficiency, stress or osteoporotic fracture of the hip (Bencardino et al. [*ACR*] 2016; *BOA* 2014; *SIGN* 2009);

however, the diagnosis of hip fracture is easily missed and, in a small minority of patients, the fracture may not be apparent on conventional radiograph (*NICE* 2017; *SIGN* 2009).

- While the sensitivity of conventional radiography for stress and insufficiency fractures increases on short-term follow-up imaging, immediate MRI is recommended as delays in diagnosis may increase the risk of nonunion, delayed union, displacement, and avascular necrosis (Bencardino et al. [*ACR*] 2016; *NICE* 2017; PLE expert panel consensus opinion).
- MRI is usually considered to be the reference standard [for radiographically occult hip fractures], as numerous studies have found MRI to have the highest accuracy (100% sensitivity and between 93% and 100% specificity), depending on experience and skill of radiologist interpreting the images (*NICE* 2017).
- In elderly and osteoporotic patients, abnormalities may not show up on bone scan for several days following injury. The sensitivity of bone scan for insufficiency fracture may also be decreased for patients on chronic steroid therapy (Bencardino et al. [*ACR*] 2017).
- In patients with insufficiency fractures of the hip, consider dual-energy x-ray absorptiometry to assess for osteoporosis (Bussières et al. 2007).

Technical notes:

- Cross-sectional imaging of the hip for insufficiency fracture should also include the sacrum and pelvis. Sacral fractures commonly occur in this population and can also result in groin/hip pain (Bencardino et al. [*ACR*] 2017; PLE expert panel consensus opinion).
- 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).
- When bone scan is used to evaluate for an occult fracture of the hip, SPECT technique should be used, if available, as it increases the specificity of the exam (Bencardino et al. [*ACR*] 2016; PLE expert panel consensus opinion).

Evidence update (2016-present):

No new low, moderate or high level evidence was found which would change the conclusions of the guidelines cited above.

Hip pain with suspected labral tear with or without femoral acetabular impingement syndrome, with or without previous surgery:

- **Green** – MRI hip without IV contrast for all ages; MR arthrography hip in patients < 65,
- **Yellow** – CT arthrography hip if the patient is unable to undergo MRI
- **Yellow** – CT bilateral hips without IV contrast with 3D reformations for surgical planning
- **Yellow** – MR arthrography hip in patients ≥ 65
- **Red** – MRI hip with IV contrast; CT hip with IV contrast; bone scan; SPECT; PET

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: none

Guideline and PLE expert panel consensus opinion summary:
Special investigations for labral tear and femoroacetabular impingement include unenhanced MRI for hip articular cartilage and labrum defects and MRI arthrography which has a high accuracy (90%) as confirmed in patients undergoing diagnostic arthroscopy for labral resection (Bussières et al. 2007, grade D recommendation).

Currently, the most common imaging procedure used to confirm the diagnosis of intra-articular pathology, such as labral tears or chondral lesions, is MRA. Compared to the gold standard of arthroscopic visual inspection, MRA has a sensitivity of 71% to 100% and a specificity of 44% to 71% in detecting a labral tear. Although MRI is not used widely to detect intra-articular injury, some investigators report high accuracy (89%-95%) in detecting labral tears (Enseki et al. *American Physical Therapy Association* [*APTA*] 2014).

CT may be used to determine the osseous architecture of the hip and thus provides additional information for surgical planning. Since it utilizes ionizing radiation, it is typically reserved for surgical planning (Enseki et al. [*APTA*] 2014).

The *American College of Radiology (ACR)* recommends MR arthrography hip (9), CT arthrography hip (7), MRI hip without IV contrast (6), and MRI hip without and with IV contrast (5) for the evaluation of chronic hip pain; radiographs negative, equivocal, or nondiagnostic; suspect labral tear with or without clinical findings consistent with or suggestive of impingement (Mintz et al. [*ACR*] 2016).

Clinical notes:

- 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).
- [Conventional] radiographs are the first imaging study in the evaluation of hip pain (Enseki et al. [*APTA*] 2014).
- 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).

- Radiographic evidence of femoroacetabular impingement is common in active patients with hip complaints. Descriptive studies based on retrospective observations report that osseous abnormalities were present in up to 87% of patients presenting with labral tears (Enseki et al. [*APTA*] 2014).
- Many *asymptomatic* patients have imaging evidence of cam and pincer FAI. Frank et al., in a 2015 systematic review of 2114 asymptomatic subjects assessed by MR or x-ray, found that 37% had cam FAI measurements and 67% had pincer FAI measurements. Of those undergoing MR, 68% had labral tears (Frank et al. 2015).
  Note: The PLE expert panel thought that this paper was important. It underscores the concept that FAI is a clinical syndrome and that FAI morphologic features are only important in young patients presenting with the appropriate symptoms and clinical signs. Conversely, the presence of these features in asymptomatic patients does not invalidate their importance in the treatment of patients with femoral acetabular impingement syndrome.
- MR arthrography is usually more accurate than plain MRI to assess the labrum and articular cartilage (Griffin et al. 2016).
- FAI is a clinical syndrome generally seen in younger patients. It is rare for patients over 65 to present with primary FAI and MR arthrography may not be appropriate in this group (PLE expert panel consensus opinion).
- 3T MRI provides better visualization of the labrum and articular cartilage resulting in improved sensitivity and specificity and may replace MR arthrography (Mintz et al. [*ACR*] 2016).
- Chondral lesions are an important component of the pathology related to FAI and labral tears, with a strong correlation between chondral loss/delamination adjacent to labral tears in patients with cam FAI (Enseki et al. [*APTA*] 2014). The integrity of the articular cartilage is of paramount importance to the health of the hip (PLE expert panel consensus opinion).
- Morphology is better characterized on cross-section imaging, either CT or MRI. This is particularly important if surgery is being considered (Griffin et al. 2016).
- Bone scan is sensitive for FAI. Focal uptake in the superior or superolateral acetabular rim on SPEC imaging has moderate specificity and sensitivity for FAI. Absence of this uptake has a high negative predictive value for FAI (Mintz et al. [*ACR*] 2016).
- Intra-articular hip injection can be performed with local anesthetic, with or without cortisone, to determine if the patient's symptoms are arising from the hip. Local anesthetic can be injected at the time of MR arthrography or CT arthrography if indicated (Mintz et al. [*ACR*] 2016; Enseki et al. [*APTA*] 2014).

<u>Technical notes:</u>

- Cartilage specific sequences (PD, PD fat saturation or T2 fat saturation) should be part of any MRI or MRA 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 MRA 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).
- If CT is obtained for surgical planning, the examination should include 3D reformations (PLE expert panel consensus opinion).

<u>Evidence update (2014-present) with selected articles from guideline bibliographies:</u>

Frank et al., in a 2015 systematic review, addressed the incidence of radiographic findings suggestive of FAI in asymptomatic individuals. The prevalence of an asymptomatic cam deformity was 37% (range, 7% to 100% between studies)-54.8% in athletes, versus 23.1% in the general population. The prevalence of asymptomatic hips with pincer deformity was 67% (range 61% to 76% between studies). Only 7 studies reported on labral injury, which was found on MRI without intra-articular contrast in 68.1% of hips. The authors concluded FAI morphologic features and labral injuries are common in asymptomatic patients (high level of evidence).

Magee et al., in a 2015 study, reported the accuracy of 3T MRI and 3T MR arthrography in the detection of acetabular labral tears and chondral defects in 43 consecutive patients undergoing arthroscopic surgery. The sensitivity for acetabular labral tears was 88-90% for 3T MRI and 90-93% for 3T MRA. The sensitivity for acetabular chondral defects was 59-65% for 3T MRI and 71-81% for 3T MRA. The authors concluded that the sensitivity of 3T MRI for acetabular labral tears was similar to that of 3T MRA. 3T MRA had increased sensitivity and specificity for chondral defects (moderate level of evidence).

Saied et al., in a 2017 systematic review and meta-analysis, aimed to detect the accuracy of conventional MRI (cMRI), direct MRA (dMRA) and indirect MRA (iMRA) 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 in the 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 dMRA. 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 dMRA. The sensitivity and specificity for iMRA were 0.722 and 0.917. The authors conclude that diagnostic test accuracy of dMRA was superior to cMRI for detection of labral and chondral lesions. Promising results were found for iMRA, but further studies will need to fully assess its diagnostic accuracy (moderate level of evidence).

Reiman et al., in a 2017 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/MRA and ultrasound, and by a moderate degree for CTA. Negative imaging findings decreased the probability that a labral tear existed by a minimal degree with use of MRA and ultrasound, a small to moderate degree with MRA, and a moderate degree with CTA. The meta-analysis showed that CTA 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) (moderate level of evidence).

Chopra et al., in a 2018 observational study, compared the diagnostic accuracy of conventional 3T MRI vs. 1.5T MRA in 68 consecutive patients (median age 32 years) with FAI. All patients underwent both MRI and MRA, 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 vs. 1.5T MRA. For acetabular cartilage defect, both readers had higher (statistically significant) sensitivities using 3T MRI vs. 1.5T MRA (p=0.02). Both readers had a slightly higher (not statistically significant) sensitivity for detecting delamination with 1.5T MRA vs. 3T MRI. The authors conclude that conventional 3T MRI is equivalent to 1.5T MRA in detecting acetabular labral tears and possibly superior to 1.5T MRA in

detecting acetabular cartilage defects in patients with suspected FAI. 3T MRI is equivalent to 1.5T MRA for diagnosing cartilage delamination (moderate level of evidence).

Naraghi and White, in a 2015 best practice review of the literature, stated that the evidence supports the use of direct MR arthrography over unenhanced MRI and indirect MR arthrography for the detection of labral and cartilage abnormalities in the hip. They noted that although high-resolution unenhanced 3T MRI appears promising, limited information in the literature supports its use in the detection and characterization of chondrolabral lesions (low level of evidence – clinical review).

Tian et al., in a 2014 retrospective study, evaluated the accuracy of 3T MRI versus 3T MR arthrography in 90 patients undergoing hip arthroscopy. 59/90 patients were shown to have labral tears at arthroscopy. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of conventional MR for evaluating the acetabular labral tears were 61.0%, 77.4%, 83.7% and 51.1% (radiologist A), and 66.1%, 74.2%, 82.9% and 53.4% (radiologist B), respectively, interobserver reliability (K = 0.645). The sensitivity, specificity, PPV and NPV of MR arthrography for assessing the acetabular labral tears were 90.5%, 84.6%, 90.5% and 84.6% (radiologist A), and 95.2%, 84.6%, 90.9% and 91.7% (radiologist B), respectively, with excellent interobserver reliability (K = 0.810). The accuracy of MR arthrography for diagnosing the acetabular labral tears were significantly higher than those of conventional MR (both $P < 0.05$) (low level of evidence).

Sutter et al., in a 2014 prospective study, compared the diagnostic performance of MR arthrography and conventional MRI for the detection of labral and articular cartilage defects. 28 patients underwent MRI, MR arthrography and subsequent hip surgery. MRA had improved sensitivity for anterior superior labral tears compared to MRI – 69-81% versus 50%. MRA also had improved sensitivity for acetabular cartilage defects compared to MRI – 71%-92% versus 58-83% (low level of evidence).

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

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

* Ultrasound has also been shown to be accurate in the evaluation of periarticular tendons and bursitis of the hip.

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: none

Guideline and PLE expert panel consensus opinion summary:
MRI is useful in detecting musculotendinous pathology, such as iliopsoas tendinopathy (Enseki et al. [*APTA*] 2014).

In the clinical diagnoses of strain, tendinitis, or tendinosis, MRI is recommended for soft tissue involvement (edema, hemorrhage, frank disruption) and bony abnormality (Bussières et al. 2007, grade D recommendation).

MRI is useful in chronic or recurrent bursitis and is most accurate for iliopsoas bursitis (Bussières et al. 2007, grade D recommendation).

[MRI] is both highly sensitive and specific for detecting many abnormalities involving the surrounding soft tissues and should, in general, be the first imaging technique used following radiographs (Mintz et al. [*ACR*] 2016).

The *American College of Radiology* (Mintz et al. [*ACR*] 2016) recommends MRI hip without IV contrast (9), US hip (7) and image-guided anesthetic +/- corticosteroid injection hip joint of surrounding structures (5) for the evaluation of chronic hip pain; radiographs negative, equivocal, or nondiagnostic; suspect extra-articular noninfectious soft-tissue abnormality, such as tendonitis.

Clinical notes:

- If the patient is unable to undergo MRI, ultrasound should be considered to evaluate for periarticular tendinopathy, tendon tear and/or bursitis (PLE expert panel consensus opinion).
- Ultrasound is useful to evaluate periarticular musculotendinous abnormalities although the accuracy may vary significantly depending on user expertise and experience. Ultrasound is also useful to guide periarticular injections and can be useful to diagnose dynamic abnormalities such as snapping iliopsoas tendons (Mintz et al. [*ACR*] 2016).

- In nontraumatic trochanteric and iliopsoas bursitis, ultrasound is an easy-to-perform and fast alternative. However, it fails to demonstrate iliopsoas bursitis in about 40% of cases (Bussières et al. 2007).
- Image-guided bursal and/or periarticular tendon injections with local anesthetic, with or without cortisone, can be useful for diagnostic and therapeutic purposes in patients with suspected periarticular tendon and bursal abnormalities (Mintz et al. [*ACR*] 2016).

Evidence update (2015-present): No new low, moderate or high level evidence was found which would change the conclusions of the guidelines cited above.

Hip pain with moderate or severe osteoarthritis on conventional radiography:

- **Green** – *
- **Yellow** – MRI hip without IV contrast in patients with new-onset severe pain, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Yellow** – CT hip without IV contrast if the patient is unable to undergo MRI and there is new-onset severe pain, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Yellow** - CT arthrography hip if the patient is unable to undergo MRI and there is new-onset severe pain, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Yellow** – Bone scan with SPECT or planar bone scan for patients if the patient is unable to undergo MRI and there is new-onset severe pain, a significant change in symptoms, or pain that is disproportionate to findings on repeat radiography
- **Red** – MRI hip with IV contrast; MR arthrography; CT hip with IV contrast; PET

* Advanced imaging is not routinely used for the diagnosis and routine management of osteoarthritis (see guideline statements below).

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: none

Guideline and PLE expert panel consensus opinion summary:
Clinicians should not use magnetic resonance imaging (MRI) as an evaluative tool to diagnose, confirm, or manage the treatment of osteoarthritis (*VA/DOD* 2014, D recommendation).

In patients with OA who have concomitant signs and symptoms of loose body, [labral] pathology or an injury with a sudden onset of pain, [locking or clicking] and/or effusion, MRI may be indicated (*VA/DOD* 2014).

Imaging is recommended if there is unexpected rapid progression of symptoms or change in clinical characteristics to determine if this relates to OA or an additional diagnosis (Sakellariou et al. *European League Against Rheumatism* [*EULAR*] 2017, Level of Evidence III-IV).

If imaging is needed, conventional radiography should be used before other modalities. To make additional diagnoses, soft tissues are best imaged by US or MRI, and bone by CT or MRI. (Sakellariou et al. [*EULAR*] 2017, Level of Evidence III-IV).

Clinical notes:

- Clinical features of osteoarthritis typically include age ≥ 40 years, hip pain only with possible protective limp, activity-induced symptoms, improvement with rest, stiffness in the morning or with periods of inactivity, and significant decrease in pain with weight loss and exercise in patients aged > 60 years (Bussières et al. 2007).
- Hip, buttock, groin and medial thigh pain may arise from the hip, spine, sacroiliac joints and knee, or from abdominal disorders (*BOA* 2014; Mintz et al. [*ACR*] 2016).
- Conventional radiography should be the initial study for the evaluation of hip pain, and may be

useful for the detection and evaluation of bone tumor, AVN and arthritis (Mintz et al. [*ACR*] 2016; Bussières et al. 2007, grade D recommendation).

- Clinicians may use conventional radiography to confirm the clinical diagnosis of hip and knee osteoarthritis (OA). Radiography can be useful to confirm the clinical diagnosis of OA and may eliminate other potential diagnoses from consideration (*VA/DOD* 2014, C recommendation).
- It is important for primary care providers to recognize the presence of certain red flags that suggest an alternative diagnosis and should prompt an immediate evaluation. Severe local inflammation, erythema, and progressive pain unrelated to usage suggest an alternative diagnosis such as septic arthritis, crystalline arthritis, inflammatory arthritis, mechanical derangement, or serious bone pathology (*VA/DOD* 2014).

Evidence update (2007-present):
Xu et al., in a 2013 study, evaluated the diagnostic performance of conventional radiography for the detection of osteoarthritis in 44 patients, with 1.5T MRI as a gold standard. Compared with MRI, radiography provided high specificity (0.76-0.90), but variable sensitivity (0.44-0.78) for diffuse cartilage damage, femoral osteophytes, acetabular subchondral cysts and bone attrition of the femoral head, and a low specificity (0.42 and 0.58) for acetabular osteophytes. The AUC of radiography for detecting overall diffuse cartilage damage, marginal osteophytes, subchondral cysts and bone attrition was 0.76, 0.78, 0.67, and 0.82, respectively. The diagnostic performance of radiography was good for bone attrition, fair for marginal osteophytes and cartilage damage, but poor for subchondral cysts (low level of evidence).

Sautner and Schueller-Weidekamm, in a 2013 review, note that for the assessment of OA, CT is still the gold standard, due to its standardized technique, its high availability and cost-effectiveness. It is the method of choice for the initial assessment of a joint. For the assessment of early diagnosis of OA, MRI is superior in the evaluation of early cartilage defects and cartilage quality, and enables the detection of bone marrow edema. Taking its high costs into account, MRI should preferably be applied in younger patients with chronic joint pain. In doubtful cases, MRI is helpful to optimize a patient's treatment, especially for preoperative planning (low level of evidence – clinical review).

Unexplained hip, groin, buttock, thigh, and/or knee pain with suspected hip etiology on physical exam and normal or minimally abnormal radiographs unresponsive to conservative therapy for an appropriate period of time:

- **Green** – MRI hip without IV contrast
- **Yellow** – MR arthrography hip for suspected intra-articular pathology
- **Yellow** – CT arthrography hip for suspected intra-articular pathology if the patient is unable to undergo MRI
- **Yellow** – CT hip without IV contrast for suspected extra-articular pathology in a patient who is unable to undergo MRI
- **Yellow** – Bone scan with SPECT or planar bone scan if the patient is unable to undergo MRI
- **Red** – MRI hip with and without IV contrast; MRI hip with IV contrast; CT hip with IV contrast; PET

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: none

Guideline and PLE expert panel consensus opinion summary:
Special investigations for the evaluation of patients with chronic hip pain (including suspected OA, inflammatory arthritis, osteonecrosis, tumors or stress fractures) unresponsive to 4 weeks of conservative therapy include MRI without contrast and MR arthrography (Bussières et al. 2007, grade D recommendation). The PLE expert panel thought that 6 weeks was a more appropriate interval to allow initial therapeutic interventions to show effectiveness (PLE expert panel consensus opinion).

The *American College of Radiology (ACR)* recommends MRI hip without IV contrast (9), image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures (8), CT hip without IV contrast (5), and MR arthrography hip (5) for the evaluation of chronic hip pain and low back, pelvic, or knee pathology; want to exclude hip as the source; radiographs negative, equivocal, or showing mild osteoarthritis (Mintz et al. [*ACR*] 2016).

The *ACR* recommends MRI hip without IV contrast (9), MR arthrography hip (9), CT arthrography hip (8), and MRI hip with and without IV contrast (5) for the evaluation of chronic hip pain to evaluate articular cartilage (Mintz et al. [*ACR*] 2016).

The ACR recommends MRI of the hip without IV contrast (9), MRI of the hip with and without IV contrast (7), Tc-99m bone scan whole body (5), CT without IV contrast for the evaluation of localized or regional symptoms with negative or indeterminate radiographs (Morrison et al. [*ACR*] 2013).

Clinical notes:

- Hip, buttock, groin and medial thigh pain may arise from the hip, spine, sacroiliac joints and knee, or from abdominal disorders. (*BOA* 2014; Mintz et al. [*ACR*] 2016)
- Conventional radiographs should be the initial study for the evaluation of hip pain, and may be useful for the detection and evaluation of bone tumor, AVN and arthritis (Mintz et al. [*ACR*] 2016; Bussières et al. 2007, grade D recommendation).

- Intra-articular hip injection can be performed with local anesthetic, with or without cortisone, to determine if the patient's symptoms are arising from the hip. Local anesthetic can be injected at the time of MR arthrography or CT arthrography, if indicated (Mintz et al. [*ACR*] 2016).
- Anesthetic injection can be considered in patients with chronic hip pain unresponsive to conservative therapy (Bussières et al. 2007, grade D recommendation).

Technical notes:

- MRI protocol of an ipsilateral hip should include 1-2 sequences of the entire bony pelvis and should include water sensitive sequences (STIR or T2 fat saturation) (PLE expert panel consensus opinion).

Evidence update (2007-present):
Keeney et al., in a 2014 retrospective study, 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 (low level of evidence).

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

Hip pain with suspected avascular necrosis (AVN)/Osteonecrosis:

- **Green** – MRI hip without IV contrast
- **Yellow** – MRI hip with IV contrast with indeterminate findings on MRI without IV contrast
- **Yellow** – bone scan with SPECT in patients who are unable to undergo MRI
- **Yellow** – CT bilateral hips without IV contrast with 3D reformations for surgical planning or in patients who are unable to undergo MRI
- **Orange** – MRI hip with and without IV contrast, except to follow-up previous MRI exams with indeterminate findings
- **Orange** – Planar bone scan, except in patients who are unable to undergo MRI and SPECT is not available.
- **Red** – MR arthrography; CT arthrography; CT hip with IV contrast; PET

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: none

Guideline and PLE expert panel consensus opinion summary:
MRI is the procedure of choice for the detection of AVN/osteonecrosis (Murphey et al. [*ACR*] 2015; Bussières et al. 2007, grade C recommendation).

MRI is useful when radiographs are normal [in patients presenting with osteonecrosis], especially in high-risk patients. Also useful are nuclear medicine and CT (when MRI is unavailable) (Bussières et al. 2007, grade B recommendation).

The *American College of Radiology* (*ACR*) recommends MRI hips without IV contrast (9), CT hips without IV contrast (5), and MRI hips without and with IV contrast (5) for the evaluation of clinically suspected osteonecrosis in an adult with normal radiographs or radiographs that show femoral head radiolucencies suspicious for osteonecrosis (Murphey et al. [*ACR*] 2015).

MRI of the hip with and without IV contrast is not usually indicated for initial advanced imaging of the hip in patients with suspected AVN. MRI with IV contrast may on occasion be useful in patients with previous MRI without contrast if findings are indeterminate for AVN versus subchondral fracture. MRI with and without IV contrast may rarely be indicated to follow-up previous MRI exams with transient osteoporosis or to follow-up previous indeterminate MRI exams (PLE expert panel consensus opinion).

The *ACR* recommends CT hips without IV contrast (9), and Tc-99m bone scan with SPECT hips (8) for the evaluation of clinically suspected osteonecrosis in adults with normal or abnormal radiographs; MRI contraindicated; further evaluation is needed (Murphey et al. [*ACR*] 2015).

CT may be useful for surgical planning to assess the severity and locations of femoral head collapse, and to assess for secondary osteoarthritis (Murphey et al. [*ACR*] 2015).

The *ACR* recommends MRI hips without IV contrast (8), and CT hips without IV contrast (7) for the evaluation of osteonecrosis with femoral head collapse by radiographs in the painful hip(s); surgery

contemplated (Murphey et al. [*ACR*] 2015).

Clinical notes:

- Clinical features of osteonecrosis typically include progressive groin pain that may refer to the knee, normal range of motion in early stages, and limitation of extension, internal rotation and abduction, limping and atrophy in advanced stages (Bussières et al. 2007).
- Factors which place patients at high risk for AVN include: Hip fractures or dislocations, chronic steroid use, organ transplant surgery, chronic alcohol abuse, hemoglobinopathy, decompression illness [barotrauma], and chronic antiretroviral medication use (Shah et al. 2015).
- Conventional radiographs are the initial study of choice in patients with suspected osteonecrosis or avascular necrosis (Murphey et al. [*ACR*] 2015).
- MRI is the most sensitive and specific imaging modality for the detection of osteonecrosis (Murphey et al. [*ACR*] 2015).
- MRI is more sensitive than planar scintigraphy for the diagnosis of AVN (Murphey et al. [*ACR*] 2015).
- SPECT imaging may improve the accuracy of radionuclide imaging for diagnosing osteonecrosis. If bone scanning is to be performed, SPECT imaging should be performed with pinhole collimation, scatter correction and iterative reconstruction (Murphey et al. [*ACR*] 2015).
- Avascular necrosis needs to be differentiated from transient osteoporosis and subchondral insufficiency fracture on MRI. MRI with IV contrast may be useful in this regard with enhancement of immediate subchondral bone being absent in patients with AVN (Murphey et al. [*ACR*] 2015).
- CT is less sensitive than MRI and bone scintigraphy, however, multidetector CT may be superior to MRI in the detection of femoral head collapse (Murphey et al. [*ACR*] 2015).

Technical notes:

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

Evidence update (2007-present):

Hu et al., in a 2015 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 (low level of evidence).

Hip pain with clinical and/or radiological suspicion for septic arthritis or osteomyelitis:

- **Green** – MRI hip without IV contrast; MRI hip with and without IV contrast
- **Yellow** – MRI hip with IV contrast in patients with recent previous MRI without IV contrast
- **Yellow** – CT hip with and/or without IV contrast in patients who are unable to undergo MRI
- **Orange** – Three-phase bone scan,* except if a patient cannot undergo MRI
- **Red** – CT arthrography; MR arthrography; PET; SPECT; conventional bone scan

*This guideline does not address evaluation of painful total hip replacement, for which three-phase bone scan might be appropriate.

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: none

Guideline and PLE expert panel consensus opinion summary:
MRI is the imaging modality of choice for infection (Bussières et al. 2007, grade D recommendation).

Nuclear medicine is very sensitive, but not specific, for suspected septic arthritis and osteomyelitis (Bussières et al. 2007, grade D recommendation).

The *American College of Radiology* recommends MRI hip with and without IV contrast (9) and MR hip without IV contrast (7) for the evaluation of chronic hip pain with abnormal radiographs for characterization of arthritis, including possible infection (Mintz et al. [*ACR*] 2017).

Clinical notes:

- Clinical features of septic arthritis of the hip typically include significant pain on movement and weight bearing, fever, and malaise (Bussières et al. 2007).
- Conventional radiographs should be the initial study for the evaluation of hip pain, and may be useful for the detection and evaluation of bone tumor, AVN and arthritis (Mintz et al. [*ACR*] 2016; Bussières et al. 2007, grade D recommendation).
- 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 (Mintz et al. [*ACR*] 2017; Bussières et al. 2007, grade D recommendation; 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).

Technical notes:

- IV contrast is useful in patients with septic arthritis and/or osteomyelitis to evaluate for periarticular abscess on MRI and CT (PLE expert panel consensus opinion).

Evidence update (2016-present) and selected articles from guideline bibliographies:
Keeney et al., in a 2014 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 (low level of evidence).

Hip pain with a bone lesion noted on radiographs:

- **Green** – MRI hip without IV contrast or MRI hip with and without IV contrast to evaluate bone lesions which are indeterminate or aggressive on radiographs
- **Yellow** – CT hip without IV contrast to evaluate an indeterminate or aggressive lesion on radiographs if the patient is unable to undergo MRI
- **Yellow** - CT hip without IV contrast to evaluate or to follow borderline or low-grade cartilaginous lesions
- **Yellow** – Whole-body bone scan with or without SPECT to evaluate for metastases in a patient with history of cancer
- **Yellow** – Whole-body bone scan with or without SPECT or PET/CT for staging of patients with indeterminate or aggressive lesions on prior MRI or CT
- **Orange** – PET, except to evaluate for metastatic disease in a patient with a known cancer and known uptake on PET when other examinations are indeterminate
- **Red** – MR arthrography; CT arthrography

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: none

Guideline and PLE expert panel consensus opinion summary:
Special investigations for tumors and metastatic lesions include nuclear medicine, CT, and MRI (Bussières et al. 2007, grade D recommendation).

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without and with IV contrast (8), MRI area of interest without IV contrast (7), CT area of interest without IV contrast (7), and Tc-99m bone scan whole body (5) for the evaluation of primary bone tumors – lesion on radiographs; indeterminate for malignancy with mineralized matrix.

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without and with IV contrast (8), MRI area of interest without IV contrast (7), CT area of interest without IV contrast (7), X-ray skeletal survey (5 – if concern that the lesion represents multiple myeloma), and Tc-99m bone scan whole body (5) for the evaluation of primary bone tumors – lesion on radiographs; indeterminate for malignancy; lytic lesion.

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without and with IV contrast (8), MRI area of interest without IV contrast (7), CT area of interest without IV contrast (7), and Tc-99m bone scan whole body (5) for the evaluation of primary bone tumors – lesion on radiographs; indeterminate for malignancy; sclerotic or mixed lytic/sclerotic lesion.

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without and with IV contrast (9), MRI area of interest without IV contrast (8), CT area of interest without IV contrast (7), Tc-99m bone scan whole body (6), X-ray skeletal survey (5 – if concern that the lesion represents multiple myeloma), CT area of interest without and with IV contrast (5), and FDG-PET/CT whole body (5) for the evaluation of primary bone tumors – lesion on radiographs; aggressive; suspicious for

malignancy.

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without and with IV contrast (8), MRI area of interest without IV contrast (7), CT area of interest without IV contrast (5), and Tc-99m bone scan whole body (5) for the evaluation of primary bone tumors – lesion with pathological fracture on radiographs; not definitively benign.

The *American College of Radiology* (Morrison et al. 2013) recommends X-ray area of interest (9), MRI area of interest without and with IV contrast (5), MRI area of interest without IV contrast (5), and CT area of interest without IV contrast (5) for the evaluation of primary bone tumors – no radiographs; "incidental" finding on MRI; not clearly benign.

The *American College of Radiology* (Morrison et al. 2013) recommends MRI area of interest without IV contrast (9), MRI area of interest without and with IV contrast (7), and X-ray area of interest (5) for the evaluation of primary bone tumors – no radiographs; "incidental" findings on CT; not clearly benign.

Clinical notes:

- Conventional radiographs in two planes are essential for the characterization of bone lesions and are prerequisite to the interpretation of bone lesions on CT, MR and PET (PLE expert panel consensus opinion).
- 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).
- Refer patients with lesions which are indeterminate or aggressive on radiography for subspecialist consultation (PLE expert panel consensus opinion).
- On a per lesion basis, the sensitivity of PET, CT, MRI and bone scintigraphy for bone metastases is 86.9%, 77.1%, 90.4% and 75.1%. The specificities are 97%, 83.2%, 96% and 93.6% respectively (Yang et al. 2011).
- The sensitivity and specificity of PET/CT for osseous and soft tissue sarcoma is 0.96 and 0.95 respectively (Muheremu et al. 2017).

Technical notes:

- 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).

Evidence update (2007-present):
Muheremu et al., in a 2017 systematic review and meta-analysis, evaluated 16 articles with 883 patients and 2,214 lesions. 9 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 (high level of evidence). 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 (high level of evidence).

Yang et al., in a 2011 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 (high level of evidence).

Keeney et al., in a 2014 retrospective study, 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 58% of patients undergoing assessment for neoplasm (low level of evidence).

Costelloe and Madewell, in a 2013 review, state that radiographs are recommended as the initial imaging modality for the evaluation of bone pain, and standard radiographic techniques are typically adequate for tumor imaging. CT with multiplanar reformations can be considered in areas with large amounts of anatomic overlap, with complex boney structures, or to evaluate mineralized matrix. MRI is appropriate for determining the extent of disease (low level of evidence – clinical review).

Nascimento et al., in a 2014 review, make the following points: When a lesion is indeterminate or shows signs of aggressiveness, MRI is indicated. MRI is superior to other modalities in detecting bone marrow lesions and tumoral tissue. MRI is very helpful in local staging and surgical planning and is useful in assessing the response to neoadjuvant therapy. All lesions which are suspicious for malignancy should undergo MR imaging with IV contrast in order to optimize border characterization, separate edema from active tumor and direct biopsy (low level of evidence – clinical review).

O'Sullivan et al., in a 2015 review, 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% (low level of evidence – clinical review).

Bloem et al., in a 2012 review, concluded that tumors and tumor-like lesions are difficult to detect on radiographs, and there should be a low threshold to go to CT or MR. MR is the most powerful tool, and is used for diagnosis, monitoring therapy, and detecting recurrence (low level of evidence – clinical review).

Bancroft et al., in a 2012 review, makes the following points: After initial evaluation with radiography, MRI is the most common modality used to establish the diagnosis and characterize osseous and soft tissue tumors of the hip. Lesions should be imaged in at least 2 orthogonal planes, using fast spin echo T1-weighted and fluid-sensitive MR pulse sequences in at least 1 of these planes. In general, a small field of view is preferred; however, the entire pelvis should be evaluated in at least one plane for appropriate staging (low level of evidence – clinical review).

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;
- Suspected osteoid osteoma;
- Primary soft tissue neoplasm;
- 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; and
- White Blood Cell scanning.

AUC Revision History:

Revision Date:	New AUC Clinical Scenario(s):	Posting Date:	Approved By:
12/04/2018	n/a	12/06/2018	CDI Quality Institute's Multidisciplinary Committee

Information on our evidence development process, including our conflicts of interest policy is available on our website at **https://www.mycdi.com/about_us/cdi_quality_institute/provider_led_entity/**