American College of Radiology
ACR Appropriateness Criteria®
Chronic Hip Pain

Variant 1: **Chronic hip pain. First test.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray pelvis	9	X-ray pelvis and x-ray hip are complementary.	☢☢
X-ray hip	9	X-ray pelvis and x-ray hip are complementary.	☢☢☢
MRI hip without IV contrast	1		O
MRI hip without and with IV contrast	1		O
US hip	1		O
CT hip without IV contrast	1		☢☢☢
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
CT arthrography hip	1		☢☢☢
MR arthrography hip	1		O
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect extra-articular noninfectious soft-tissue abnormality, such as tendonitis.**

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without IV contrast	9		O
US hip	7		O
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	5		Varies
MRI hip without and with IV contrast	3		O
MR arthrography hip	2		O
CT hip without IV contrast	1		☢☢☢
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
CT arthrography hip	1		☢☢☢
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 3: **Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect impingement.**

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without IV contrast	8		O
MR arthrography hip	8		O
CT arthrography hip	7		☢☢☢
CT hip without IV contrast	5		☢☢☢
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	5	This procedure is often done at the same time as MR or CT arthrography.	Varies
US hip	4		O
MRI hip without and with IV contrast	3		O
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 4: **Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect labral tear with or without clinical findings consistent with or suggestive of impingement.**

Radiologic Procedure	Rating	Comments	RRL*
MR arthrography hip	9		O
CT arthrography hip	7		☢☢☢
MRI hip without IV contrast	6		O
MRI hip without and with IV contrast	5		O
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	5	This procedure is often done at the same time as MR or CT arthrography.	Varies
CT hip without IV contrast	1		☢☢☢
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
US hip	1		O
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 5: **Chronic hip pain. Evaluate articular cartilage. Next test after radiographs.**

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without IV contrast	9		O
MR arthrography hip	9		O
CT arthrography hip	8		☢☢☢
MRI hip without and with IV contrast	5		O
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	4	This procedure is often done at the same time as MR or CT arthrography.	Varies
CT hip without IV contrast	1		☢☢☢
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
US hip	1		O
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 6: **Chronic hip pain. Radiographs positive. Arthritis of uncertain type. Infection is a consideration**.

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without and with IV contrast	9		O
Aspiration hip	9		Varies
MRI hip without IV contrast	7		O
US hip	5		O
Tc-99m 3-phase bone scan hip	4	This procedure is performed with SPECT/CT and labeled white blood cell imaging.	☢☢☢
CT hip without IV contrast	2		☢☢☢
CT hip with IV contrast	2		☢☢☢
CT hip without and with IV contrast	2		☢☢☢
F-18 fluoride PET hip	2		☢☢☢
CT arthrography hip	1		☢☢☢
MR arthrography hip	1		O
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 7: **Chronic hip pain. Radiographs suggestive of pigmented villonodular synovitis or osteochondromatosis.**

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without IV contrast	9		O
CT arthrography hip	5		☢☢☢
Aspiration hip	4		Varies
MRI hip without and with IV contrast	2		O
US hip	2		O
CT hip without IV contrast	2		☢☢☢
CT hip with IV contrast	2		☢☢☢
CT hip without and with IV contrast	2		☢☢☢
MR arthrography hip	2		O
Tc-99m bone scan hip	2		☢☢☢
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	2		Varies
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 8: **Chronic hip pain and low back, pelvic, or knee pathology. Want to exclude hip as the source. Radiographs negative, equivocal, or showing mild osteoarthritis.**

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without IV contrast	9		O
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	8		Varies
CT hip without IV contrast	5		☢☢☢
MR arthrography hip	5		O
US hip	4		O
MRI hip without and with IV contrast	2		O
CT arthrography hip	2		☢☢☢
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 9: **Computer navigation of hip arthroplasty or modeling.**

Radiologic Procedure	Rating	Comments	RRL*
CT hip without IV contrast	9		☢☢☢
X-ray pelvis	1		☢☢
X-ray hip	1		☢☢☢
MRI hip without IV contrast	1		O
MRI hip without and with IV contrast	1		O
US hip	1		O
CT hip with IV contrast	1		☢☢☢
CT hip without and with IV contrast	1		☢☢☢
CT arthrography hip	1		☢☢☢
MR arthrography hip	1		O
Tc-99m bone scan hip	1		☢☢☢
F-18 fluoride PET hip	1		☢☢☢
Image-guided anesthetic +/- corticosteroid injection hip joint or surrounding structures	1		Varies
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

CHRONIC HIP PAIN

Expert Panel on Musculoskeletal Imaging: Douglas N. Mintz, MD [1]; Catherine C. Roberts, MD[2]; Jenny T. Bencardino, MD[3]; Steven J. Baccei, MD[4]; Michelle Caird, MD[5]; R. Carter Cassidy, MD[6]; Eric Y. Chang, MD[7]; Michael G. Fox, MD[8]; Soterios Gyftopoulos, MD[9]; Mark J. Kransdorf, MD[10]; Darlene F. Metter, MD[11]; William B. Morrison, MD[12]; Zehava S. Rosenberg, MD[13]; Nehal A. Shah, MD[14]; Kirstin M. Small, MD[15]; Naveen Subhas, MB[16]; Siddharth Tambar, MD[17]; Jeffrey D. Towers, MD[18]; Joseph S. Yu, MD[19]; Barbara N. Weissman, MD.[20]

Summary of Literature Review

Introduction/Background

Chronic hip pain and/or groin pain is a perplexing clinical problem. Symptoms may be related to numerous etiologies, including trauma, neoplasms, and arthropathies. Pain may be due to osseous, intra-articular, periarticular, or soft-tissue pathology [1-3]. Referred pain from the lumbar spine, sacroiliac joints, or knee may add to the potentially confusing clinical picture [4]. Very few references deal specifically with chronic hip pain, although the imaging of specific disorders has been the subject of many articles and case reports.

Clinical data are essential for selecting the most appropriate imaging techniques in patients with chronic hip pain. A targeted history and physical examination, including provocative maneuvers, range of motion, gait abnormalities, locking or snapping, duration of symptoms, and pain patterns (eg, worse at night and relieved by aspirin typical of osteoid osteoma, or steroid use as a cause of osteonecrosis [ON]) can be very useful for reducing the potentially long list of differential diagnoses [3,5]. Similar attention must be paid to the knees and spine as potential sources of pain.

Overview of Imaging Modalities

Obtaining radiographs is a good first step to screen hip pain. They may provide specific information for common disorders such as arthritis or less common disorders such as bone tumors. In many instances, such as osteoarthritis (OA) or advanced ON, they may be the only imaging necessary. The progression through the imaging armamentarium is not sequential and depends on the appearance of the radiographs and the suspected diagnosis.

After radiographs, imaging modalities include computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), and nuclear medicine testing (bone scan and positron emission tomography [PET]). CT and MRI are tomographic techniques that lend themselves to the creation of 3-D images, which are useful to define the complex bony anatomy of the hip.

MRI and CT can be performed with contrast, either injected intravenously or intra-articularly. Intravenous (IV) contrast is generally used to evaluate soft tissues and aid or enhance the imaging contrast between vascular and nonvascular tissues. For example, a vascular tumor may be more readily visible on a CT scan with IV contrast [6,7].

With time, intravenously injected MRI contrast also leaks into the hip joint, creating an arthrographic image (so-called indirect arthrography). Contrast in the joint from indirect arthrography is also used in delayed gadolinium-enhanced MRI of cartilage (dGEMRIC), a technique of ultrastructural cartilage imaging. Other techniques of ultrastructural imaging on MRI such as T2 mapping and T1rho do not require IV contrast.

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Direct arthrography creates images with a lot of imaging contrast between the articular surfaces of the joint and the contrast agent, allowing detection of defects in articular cartilage, labrum, and capsule and outlining structures in the joint, such as synovitis or cartilaginous bodies. The use of intra-articular contrast is somewhat controversial, with some radiology centers strongly preferring or avoiding its use. When arthrography is performed, a simultaneous intra-articular injection of anesthetic and/or steroid can provide diagnostic information and be therapeutic, as further discussed below.

US is a noninvasive, user-dependent technique, free of ionizing radiation, that can be used to evaluate specific questions about superficial structures, such as the abductor tendons for tendinosis or calcific bursitis, as well as deeper structures such as the iliopsoas and adductor tendons. It is also useful for guiding injections. US may reliably diagnose most anterior acetabular labral tears [8], although some authors do not find US as sensitive as CT arthrography [9].

The nuclear medicine study is primarily the bone scan, in which injected radioactive material goes to areas of active bone turnover. The classic bone scan is performed using a radioactive technetium-labeled bisphosphonate (technetium Tc-99m methylene diphosphonate [MDP]). Variations include multiple phases of image acquisition, local or whole-body acquisitions, and tomographic acquisitions using single-photon emission computed tomography (SPECT) or SPECT/CT. Another agent that can go to bone is radioactive sodium fluoride 18 (^{18}F-fluoride) and the bone scan using that agent uses PET, yielding ^{18}F-fluoride PET. This is in distinction to fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET, more often used in brain, cardiac, and tumor imaging. Fluoride 18 PET can be used interchangeably with Tc-99m MDP bone scan [10].

Injections of anesthetic, with or without corticosteroids, are often used as a diagnostic test to distinguish the source of pain. An intra-articular injection relieving pain suggests that the pain is coming from the joint. Similarly, trochanteric pain may be relieved by trochanteric injection and iliopsoas pain by iliopsoas injection. Joint aspirations with fluid examination/culture can exclude joint infections. These injections/aspirations should be guided by imaging.

Discussion of Imaging Modalities by Variant

Variant 1: Chronic hip pain. First test.

Depending on history and physical examination, imaging may not be necessary to evaluate all hip pain. A directed examination with a particular suspected problem may direct more specific targeted imaging (eg, US for abductor tendinosis/trochanteric bursitis or spine imaging for referred pain).

Radiographs should be obtained first in most, if not all, cases [11] and may provide specific information for common disorders such as arthritis or less common disorders such as primary bone tumors. This is opinion or dogma without good scientific evidence [12]. For certain disorders, such as dysplasia or femoroacetabular impingement (FAI), specialized views such as the false profile or a Dunn view can provide more detailed evaluation of the anatomy [13]. Radiography is an excellent screening tool. For many disorders, a view of the pelvis and additional image of the proximal femur is better than radiographs limited to the ipsilateral hip. Whether the radiographs are normal or not, they are often of considerable value for the selection of additional imaging techniques and for comparison with studies such as MRI, CT, radionuclide bone scans, and ^{18}F-fluoride PET [14-16].

For OA, a common entity, physical examination and radiography may be better than MRI and have reasonable sensitivity and specificity [17-19].

Aspiration and injection are not currently performed until a diagnosis is suspected.

Variant 2: Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect extra-articular noninfectious soft-tissue abnormality, such as tendonitis.

Soft tissues are best evaluated on MRI and US [20]. CT is less sensitive for soft-tissue evaluation.

MRI is frequently performed after initial radiographs to detect osseous and soft-tissue abnormalities [21-36]. It 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 [21-28,30-32,36,37]. MRI is useful for examining surrounding soft-tissue entities such as iliopsoas or subiliacus bursitis, athletic pubalgia, trochanteric bursitis, abductor tendinosis/tears, calcific tendonitis, and hamstring injuries and for sources of

referred pain from spine or knee [3]. Some secondary signs may suggest snapping hip syndrome (coxa sultans) [38].

Other causes of a chronically painful hip for which MRI has been used with considerable success include acute and chronic soft-tissue injuries [23,24,27,30-32,39,40], inflammation [28,41], and tumors [21,42-44]. IV gadolinium chelate agents or US can be used to differentiate between joint fluid and synovitis [41,45]. IV contrast is rarely needed for MRI.

US can be used to localize fluid collections, such as paralabral cysts, for aspiration and injection [46,47]. US can also be used to evaluate snapping hip [38].

Other techniques such as fluoroscopic motion studies (with or without contrast) and US are useful to evaluate periarticular conditions such as snapping iliopsoas tendon [32,43] and extra-articular impingements. Cardinal et al [48] used real-time US to evaluate the snapping iliopsoas tendon [49]. This method is noninvasive, which is an advantage compared with injection of the tendon sheath and fluoroscopic evaluation.

Diagnostic and therapeutic injections are safe and useful tools for confirming the location of pain and, in some cases, helping in its control for a short period [50-52].

Trochanteric and iliopsoas bursal/peritendinous injections may be useful in determining the cause of hip pain [53]. Aspiration is also critical in diagnosing the presence of crystal disease [54].

Nuclear medicine does not currently play a role in the workup of these conditions.

Variant 3: Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect impingement.

Osseous abnormalities are often evident on radiographs (incidence unverified), but cross-sectional imaging is more sensitive for many abnormalities. Intrinsic bony abnormalities include fracture, ON, and tumor. MRI is sensitive and specific. Further specific discussions about metastatic disease and stress fractures are presented in other American College of Radiology (ACR) Appropriateness Criteria® documents (see below). Scintigraphy is sensitive but not specific. Image-guided injections have a role in distinguishing between intra-articular and extra-articular abnormalities but not in further evaluating a suspected bone abnormality. Intra-articular injections can be performed, sometimes at the time of arthrography. If pain is relieved, the pathology is felt to be intra-articular.

Arthrography is for intra-articular abnormalities. US is limited in its evaluation of bone and cannot evaluate abnormalities deep to the cortex. Dynamic US can be useful to look for extra-articular impingements. CT is an excellent tool, but abnormalities are not as evident as they are on MRI, and tissue characterization is less robust.

In the presence of normal radiographs and in the absence of ready access to MRI, a bone scan using ^{18}F-fluoride PET or radionuclide bone scans are effective for detecting or excluding subtle osseous abnormalities. The bone scan can be performed using SPECT to improve sensitivity and can be combined with CT or MRI [55].

Extrinsic bony pathology includes dysplasia and the impingement syndromes—both intra-articular (FAI) and extra-articular (ischiopelvic, ischiotrochanteric, subspinous, and femoropelvic). MRI and CT arthrography are useful for evaluating articular cartilage and labrum. Hip cartilage abnormalities also can be successfully evaluated by high-resolution CT arthrography [6,7,56,57] or digital tomosynthesis (x-ray tomography) [58].

With appropriate operator expertise, US may reliably diagnose most anterior acetabular labral tears [8], although some authors do not find US as sensitive as CT arthrography [9]. CT is additionally used, especially preoperatively, in assessing bony anatomy in the setting of FAI and dysplasia [59-61]. Three-dimensional reconstructions based on CT and MRI are an accurate tool for quantifying the femoral head-neck morphology for providing a noninvasive assessment of hips at risk of FAI [62]. Software programs can use CT and MRI data to create models of the hip that allow motion analysis for assessing impingements. CT data are also used in computer navigation of arthroplasty. CT, MRI, and US can be useful to evaluate extra-articular impingements [63,64].

Variant 4: Chronic hip pain. Radiographs negative, equivocal, or nondiagnostic. Suspect labral tear with or without clinical findings consistent with or suggestive of impingement.

For evaluating labral tears, MRI with or without arthrography can be used [65-68]. Direct MR arthrography with the intra-articular injection of a dilute (1:200) solution of gadolinium chelate in saline has been established as a reliable technique for diagnosing acetabular labral tears [65-70] that are frequently associated with FAI [71,72] and may be an effective tool in assessing acetabular cartilage delamination [73]. However, several investigators

suggest that high-resolution 3T MRI may improve the visualization of the acetabular labrum and the hyaline articular cartilage [74,75], which may obviate the need for intra-articular contrast [76]. Ultrastuctural cartilage imaging may prove to be useful to determine potential timing of surgery or whether surgery would be appropriate for FAI [77,78]. One of these techniques (dGEMRIC) requires IV contrast administration and exercising the patient [79,80].

Other investigators have obtained satisfactory results in detecting labral and hyaline cartilage lesions with high-resolution MRI of the hip at 1.5T without intra-articular contrast [81,82]. Indirect MR arthrography, in which gadolinium chelate contrast is administered by IV injection and diffuses into the joint space through the synovium, has been proposed as an alternative to direct MR arthrography for detecting intra-articular disorders [36,83-85]. It is faster and easier to perform than direct arthrography and does not require fluoroscopy. It suffers from less consistent enhancement of the joint space as well as inability to distend the joint capsule. Its accuracy in assessing the hyaline articular cartilage and the acetabular labrum of the hip is uncertain. Some centers include radial imaging or radial reconstructions on CT and/or MRI to evaluate the shape of the femoral neck.

MR arthrography in overall published data is superior to CT arthrography and noncontrast MRI for evaluation of labral tears [7,86]. However, in some articles, CT arthrography and noncontrast MRI fare better [82,87-89]. CT arthrography has been shown to be better than MRI for chondral lesions [87]. FAI has components that are intra-articular and extra-articular. Although no studies support it, surgeons may use both MRI and CT in order to define the joint (labrum and articular cartilage) and the bone. Measurements can be performed on radiography, CT, and MRI [13,59-61,90].

Although not the modality of choice in evaluating labral pathology and FAI, radiotracer uptake in the superior or superomedial aspect of the acetabular rim on skeletal scintigraphy has been reported as a characteristic feature of a labral tear. Absence of this pattern carries a high negative predictive value for the diagnosis [91]. Focal radiotracer uptake on SPECT images localized to the superolateral acetabular rim and/or anterolateral femoral head-neck junction shows a moderate sensitivity and specificity in diagnosis of FAI [92].

Diagnostic joint injections are safe and useful tools for confirming the etiology of pain (such as labral tear) [50-52]. US can also be used to localize paralabral cysts for aspiration and injection [46,47]. It is not as sensitive as other modalities for detecting labral tears [9].

Variant 5: Chronic hip pain. Evaluate articular cartilage. Next test after radiographs.

Direct visualization of articular cartilage is possible using those imaging techniques that provide either intrinsic contrast (MRI and US) or extrinsic contrast (any type of arthrography) [58]. Different methods of chondral imaging are possible on routine MRI and there are ultrastructural techniques [93] (T2 mapping, T1rho, dGEMRIC, sodium imaging) that are mostly used for research. MRI, MR arthrography, and CT arthrography can all give excellent delineation of articular cartilage [7,56,94]. Grading systems for cartilage [95,96] are primarily used for research.

The use of IV contrast except as used for indirect MR arthrography or dGEMRIC imaging does not help to delineate articular cartilage. It may help to evaluate synovitis. US is limited in the hip by its inability to evaluate the acetabular or the majority of the femoral head cartilage. The acoustic window to see articular cartilage in the hip is limited. Nuclear medicine techniques (bone scan and PET) are not useful for cartilage imaging.

Intra-articular anesthetic/steroid injections can be performed, sometimes at the time of arthrography, as a diagnostic/therapeutic tool rather than to evaluate articular cartilage directly.

Variant 6: Chronic hip pain. Radiographs positive. Arthritis of uncertain type. Infection is a consideration.

A rheumatologic evaluation may be appropriate, including bloodwork and evaluation for other areas of abnormality, perhaps with bone scan or ^{18}F-fluoride PET. The best way to exclude septic arthritis is by joint aspiration. MRI is a noninvasive option. In the pediatric population, where debridement will be performed, US may be used to identify the effusion before joint aspiration or surgery [97]. If an infectious etiology leads to chronic pain, less aggressive organisms must be considered. Tuberculous septic arthritis has been diagnosed with FDG-PET imaging [98], but this is not typical.

Although CT scan can demonstrate erosions and enthesophytes before radiography, it has not been shown to specifically evaluate infection. As in variant 8, it can be used to evaluate soft-tissue calcifications.

Variant 7: Chronic hip pain. Radiographs suggestive of pigmented villonodular synovitis or osteochondromatosis.

Other intra-articular sources of pain such as synovitis, whether inflammatory (eg, Lyme disease), proliferative (eg, synovial chondromatosis), or neoplastic (eg, chondroma), are well demonstrated on MRI. It can be quite difficult to tell pigmented villonodular synovitis from synovial chondromatosis and other proliferative synovial processes. CT might help to look for calcifications. MRI including a gradient-echo sequence may be useful. The diagnosis may require a tissue sample.

Nuclear medicine does not currently play a role in the workup of these conditions.

Image-guided aspiration/injections demonstrate brown or bloody aspirate in patients with the diffuse form of pigmented villonodular synovitis [99,100]. CT, MR, or x-ray arthrography can be useful to determine if a body is intra-articular.

Variant 8: Chronic hip pain and low back, pelvic, or knee pathology. Want to exclude hip as the source. Radiographs negative, equivocal, or showing mild osteoarthritis.

After radiography, MRI is the best next test to screen the hip for significant pathology.

As described in variant 2, direct injections can be used to assess if pain is related to the hip.

As described in variant 2, US is useful to examine soft-tissue structures around the hip for specific diagnoses such as trochanteric bursitis.

Nuclear medicine does not currently play a role in the workup of these conditions. CT is more sensitive than radiographs at evaluating joint space narrowing but has not been shown to have a role for this indication.

Variant 9: Computer navigation of hip arthroplasty or modeling.

CT data can be used to guide computer-navigated surgery. This CT is only for navigation, determining exact anatomy and position of instruments at the time of surgery. Such a CT is not for diagnosis but is prescribed using specifications defined by device companies to guide computer-navigated surgery. CT and MRI data can also be used to make 3-D models of bony anatomy and to create custom prostheses. Cross-sectional data from CT or MRI can also be used to perform virtual surgery. Models can allow one to define the parameters of bony resection and do the surgery on the computed model. Models can also pair with computer-assisted surgery, for example, resect a cam lesion in FAI according to a prescribed plan [101]. This is different from templating arthroplasties, for which one uses radiographs.

The Food and Drug Administration is considering an application from a company that uses MRI for modeling. MRI will likely be able to be used for this indication in the near future.

Other modalities such as radiographs and nuclear medicine techniques do not play a role in modeling.

Injections are not used for this indication.

Other Diagnoses

Since chronic hip pain can have many etiologies, the causes are covered in more than 1 of the appropriateness criteria documents. Diagnoses covered in other topics are as follows:

Metastatic bone disease is covered in the ACR Appropriateness Criteria® "Metastatic Bone Disease" [102].

Stress fractures are covered in the ACR Appropriateness® Criteria "Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae" [103].

Bone tumors, including osteoid osteomas, are covered in the ACR Appropriateness Criteria® "Primary Bone Tumors" [104].

Atypical femur fracture associated with bisphosphonate, if it is not apparent on radiography, is examined in the ACR Appropriateness Criteria® "Osteoporosis and Bone Mineral Density" [105].

ON is covered in the ACR Appropriateness Criteria® "Osteonecrosis of the Hip" [106].

Summary of Recommendations

- Radiographs of the pelvis and hip should be the first test ordered for the evaluation of patients with chronic hip pain.
- MRI hip without IV contrast or US hip is appropriate in patients with chronic hip pain when radiographs are negative, equivocal, or nondiagnostic and there is suspicion for an extra-articular noninfectious soft-tissue abnormality such as tendonitis.
- MRI hip without IV contrast, MR arthrography, or CT arthrography is appropriate in patients with chronic hip pain when radiographs are negative, equivocal, or nondiagnostic and there is a suspicion for impingement.
- MR arthrography or CT arthrography is appropriate in patients with chronic hip pain when radiographs are negative, equivocal, or nondiagnostic and a labral tear is suspected.
- MRI hip without IV contrast, MR arthrography, or CT arthrography is appropriate after radiographs in patients with chronic hip pain to evaluate articular cartilage.
- MRI hip with or without IV contrast or hip aspiration is appropriate after positive radiographs in patients with chronic hip pain with suspected arthritis when infection is a consideration.
- MRI hip without IV contrast is appropriate in patients with chronic hip pain when radiographs are suggestive of pigmented villonodular synovitis or osteochondromatosis.
- MRI hip without IV contrast image–guided anesthetic with or without corticosteroid is appropriate to exclude the hip as the source of pain in patients with chronic hip pain and low back, pelvic, or knee pathology with negative or equivocal radiographs or radiographs showing mild osteoarthritis. CT hip without contrast is the preferred modality for computer-navigated surgery.

Summary of Evidence

Of the 106 references cited in the *ACR Appropriateness Criteria® Chronic Hip Pain* document, 5 are categorized as therapeutic references including 3 good-quality studies. Additionally, 98 references are categorized as diagnostic references including 2 well-designed studies, 16 good-quality studies, and 18 quality studies that may have design limitations. There are 64 references that may not be useful as primary evidence. There are 3 references that are meta-analysis studies.

The 106 references cited in the *ACR Appropriateness Criteria® Chronic Hip Pain* document were published from 1985 through 2016.

Although there are references that report on studies with design limitations, 21 well-designed or good-quality studies provide good evidence.

Relative Radiation Level Information

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

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

Supporting Documents

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

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