

**American College of Radiology
ACR Appropriateness Criteria®
Chronic Knee Pain**

Variant 1: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography knee	Usually Appropriate	☼
Image-guided aspiration knee	Usually Not Appropriate	Varies
CT arthrography knee	Usually Not Appropriate	☼
CT knee with IV contrast	Usually Not Appropriate	☼
CT knee without and with IV contrast	Usually Not Appropriate	☼
CT knee without IV contrast	Usually Not Appropriate	☼
MR arthrography knee	Usually Not Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
MRI knee without IV contrast	Usually Not Appropriate	○
Bone scan knee	Usually Not Appropriate	☼☼☼
US knee	Usually Not Appropriate	○
Radiography hip ipsilateral	Usually Not Appropriate	☼☼☼

Variant 2: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph negative or demonstrates joint effusion. Next imaging procedure.

Procedure	Appropriateness Category	Relative Radiation Level
MRI knee without IV contrast	Usually Appropriate	○
Image-guided aspiration knee	May Be Appropriate	Varies
CT arthrography knee	May Be Appropriate	☼
CT knee without IV contrast	May Be Appropriate	☼
US knee	May Be Appropriate (Disagreement)	○
Radiography hip ipsilateral	May Be Appropriate	☼☼☼
Radiography lumbar spine	May Be Appropriate	☼☼☼
MR arthrography knee	May Be Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
CT knee with IV contrast	Usually Not Appropriate	☼
CT knee without and with IV contrast	Usually Not Appropriate	☼
Bone scan knee	Usually Not Appropriate	☼☼☼

Variant 3:

Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates osteochondritis dissecans (OCD), loose bodies, or history of cartilage or meniscal repair. Next imaging procedure.

Procedure	Appropriateness Category	Relative Radiation Level
MRI knee without IV contrast	Usually Appropriate	○
CT arthrography knee	May Be Appropriate	⊕
CT knee without IV contrast	May Be Appropriate	⊕
MR arthrography knee	May Be Appropriate (Disagreement)	○
US knee	Usually Not Appropriate	○
Image-guided aspiration knee	Usually Not Appropriate	Varies
CT knee with IV contrast	Usually Not Appropriate	⊕
CT knee without and with IV contrast	Usually Not Appropriate	⊕
MRI knee without and with IV contrast	Usually Not Appropriate	○
Bone scan knee	Usually Not Appropriate	⊕⊕⊕
Radiography hip ipsilateral	Usually Not Appropriate	⊕⊕⊕

Variant 4:

Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates degenerative changes or chondrocalcinosis. Next imaging procedure.

Procedure	Appropriateness Category	Relative Radiation Level
MRI knee without IV contrast	May Be Appropriate	○
Image-guided aspiration knee	May Be Appropriate (Disagreement)	Varies
CT knee without IV contrast	May Be Appropriate	⊕
MRI knee without and with IV contrast	Usually Not Appropriate	○
US knee	Usually Not Appropriate	○
CT arthrography knee	Usually Not Appropriate	⊕
CT knee with IV contrast	Usually Not Appropriate	⊕
CT knee without and with IV contrast	Usually Not Appropriate	⊕
MR arthrography knee	Usually Not Appropriate	○
Bone scan knee	Usually Not Appropriate	⊕⊕⊕
Radiography hip ipsilateral	Usually Not Appropriate	⊕⊕⊕

Variant 5:

Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates signs of prior osseous injury (ie, Segond fracture, tibial spine avulsion, etc). Next imaging procedure.

Procedure	Appropriateness Category	Relative Radiation Level
MRI knee without IV contrast	Usually Appropriate	○
CT arthrography knee	May Be Appropriate	⊕
CT knee without IV contrast	May Be Appropriate	⊕
Image-guided aspiration knee	Usually Not Appropriate	Varies
CT knee with IV contrast	Usually Not Appropriate	⊕
CT knee without and with IV contrast	Usually Not Appropriate	⊕
MR arthrography knee	Usually Not Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
Bone scan knee	Usually Not Appropriate	⊕⊕⊕
US knee	Usually Not Appropriate	○
Radiography hip ipsilateral	Usually Not Appropriate	⊕⊕⊕

CHRONIC KNEE PAIN

Expert Panel on Musculoskeletal Imaging: Michael G. Fox, MD, MBA^a; Eric Y. Chang, MD^b; Behrang Amini, MD, PhD^c; Stephanie A. Bernard, MD^d; Tetyana Gorbachova, MD^e; Alice S. Ha, MD^f; Ramesh S. Iyer, MD^g; Kenneth S. Lee, MD, MBA^h; Darlene F. Metter, MDⁱ; Pekka A. Mooar, MD^j; Nehal A. Shah, MD^k; Adam D. Singer, MD^l; Stacy E. Smith, MD^m; Mihra S. Taljanovic, MD, PhDⁿ; Ralf Thiele, MD^o; Kathy M. Tynus, MD^p; Mark J. Kransdorf, MD.^q

Summary of Literature Review

Background/Introduction

Chronic knee pain affects tens of millions of people in the United States annually, with the pain sometimes highly disabling and often negatively impacting the patient's quality of life. Chronic knee pain has numerous causes, and it can present with localized or diffuse symptoms. Osteoarthritis is the most common cause of chronic knee pain with the knee the most common lower extremity joint impacted by osteoarthritis [1].

Typically, radiography is the initial imaging study used to evaluate chronic pain in a native knee. When pain persists but the initial radiographs are normal or demonstrate a joint effusion, MRI is usually considered the next imaging study. However, the use of MRI may be premature and unnecessary in some patients, as it is estimated that approximately 20% of patients with chronic knee pain have had an MRI performed without recent (within the prior year) radiographs [2].

This document discusses 5 variants for imaging chronic pain in a native knee in patients ≥ 5 years of age. The variants discussed include: (1) initial examination; (2) initial radiograph is normal or demonstrates a joint effusion; (3) initial radiograph demonstrates osteochondritis dissecans (OCD), loose bodies or history of cartilage, or meniscal repair; (4) initial radiograph demonstrates osteoarthritis or chondrocalcinosis; and (5) initial radiograph demonstrates signs of prior (chronic) knee injury (ie, Segond fracture, tibial spine avulsion, etc).

To evaluate knee pain associated with other conditions, please refer to the following ACR Appropriateness Criteria[®] topic on: "[Osteonecrosis of the Hip](#)" [3] for osteonecrosis, "[Acute Trauma to the Knee](#)" for acute knee injuries [4], "[Imaging After Total Knee Arthroplasty](#)" for patients with total knee arthroplasty [5], "[Soft-Tissue Masses](#)" for a patient with a suspected soft-tissue mass [6], "[Primary Bone Tumors](#)" for a patient with a suspected or known bone tumor [7], and "[Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis](#)" for patient with suspected arthritis or synovitis [8].

Special Imaging Considerations

Knee radiographs should include at least one frontal projection of one or both knees (anteroposterior, Rosenberg, or tunnel), a tangential patellar view, and a lateral view of the affected knee [2,9]. Standing radiographs more accurately reflect medial and lateral compartment cartilage loss than supine radiographs with the posteromedial and posterolateral joint compartments more accurately assessed using a weight-bearing flexion posteroanterior radiograph [9,10].

Discussion of Procedures by Variant

Variant 1: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial imaging.

Radiography Knee

Radiographs should be the initial imaging study for chronic knee pain. In elderly patients, the most common source of chronic knee pain is osteoarthritis. Conventional radiographic diagnosis of osteoarthritis includes joint space narrowing, osteophytes, subchondral cysts, and subarticular sclerosis [11]. Articular cartilage is evaluated

^aMayo Clinic Arizona, Phoenix, Arizona. ^bPanel Chair, VA San Diego Healthcare System, San Diego, California. ^cThe University of Texas MD Anderson Cancer Center, Houston, Texas. ^dPenn State Milton S. Hershey Medical Center, Hershey, Pennsylvania. ^eAlbert Einstein College of Medicine, Philadelphia, Pennsylvania. ^fUniversity of Washington, Seattle, Washington. ^gSeattle Children's Hospital, Seattle, Washington. ^hUniversity of Wisconsin Hospital & Clinics, Madison, Wisconsin. ⁱUT Health San Antonio, San Antonio, Texas. ^jTemple University Hospital, Philadelphia, Pennsylvania; American Academy of Orthopaedic Surgeons. ^kBrigham & Women's Hospital, Boston, Massachusetts. ^lEmory University School of Medicine, Atlanta, Georgia. ^mBrigham & Women's Hospital & Harvard Medical School, Boston, Massachusetts. ⁿUniversity of Arizona, Tucson, Arizona. ^oUniversity of Rochester School of Medicine and Dentistry, Rochester, New York; American College of Rheumatology. ^pNorthwestern Memorial Hospital, Chicago, Illinois; American College of Physicians. ^qSpecialty Chair, Mayo Clinic, Phoenix, Arizona.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Reprint requests to: publications@acr.org

indirectly on radiographs by joint space narrowing and changes in the subchondral bone [10]. When a severe varus or valgus deformity is present, significant cartilage loss in the apparently “wider” compartment may not be evident [11,12]. Conversely, joint space narrowing may be caused by meniscal extrusion or degeneration rather than cartilage loss [11].

Chronic knee pain is associated with the radiographic demonstration of osteophytes with the development of a “bone-on-bone” appearance or complete joint space loss on subsequent radiographs indicating disease progression and potentially indicating the need for arthroplasty [11-13].

Radiography Hip

An ipsilateral hip radiograph is usually not indicated as a first imaging examination.

CT Knee

CT is usually not indicated as a first imaging examination.

CT Arthrography Knee

CT arthrography is usually not indicated as a first imaging examination.

MRI Knee

MRI is usually not indicated as a first imaging examination. To avoid unnecessary MRI, assessment of current radiographs (within the prior year) is required [2].

MR Arthrography Knee

MR arthrography is usually not indicated as a first imaging examination.

US Knee

Ultrasound (US) is usually not indicated as a first imaging examination.

Bone Scan Knee

Radionuclide bone scan is usually not indicated as a first imaging examination.

Image-Guided Aspiration Knee

Joint aspiration is usually not indicated as a first imaging examination.

Variant 2: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph negative or demonstrates joint effusion. Next imaging procedure.

Radiography Hip

In patients with chronic knee pain, referred pain from the hip must be considered, especially if the knee radiographs are unremarkable and there is clinical evidence or concern for hip pathology [14].

Radiography Lumbar Spine

In patients with chronic knee pain, referred pain from the lower back must be considered, especially if the knee radiographs are unremarkable and there is clinical evidence or concern for lumbar spine pathology.

CT Knee

CT without intravenous (IV) contrast may be indicated to evaluate the patellofemoral anatomy in the setting of chronic knee pain related to repetitive patellofemoral subluxation or maltracking [15]. CT can also be used to evaluate trochlear morphology and the tibial tubercle-trochlear groove distance. CT with IV contrast is usually not indicated when initial radiograph is negative or demonstrates a joint effusion.

CT without and with IV contrast is not routinely performed when initial radiographs are negative.

CT Arthrography Knee

When an intra-articular abnormality is suspected, CT arthrography may be used instead of MRI to evaluate the menisci and articular cartilage [16].

MRI Knee

When initial radiographs are normal or reveal a joint effusion but pain persists, the next indicated study is usually MRI without IV contrast, which is more sensitive than radiography [11].

MRI accurately depicts the extent of an effusion, presence of synovitis, and presence or rupture of a popliteal cyst [17]. Subchondral cysts, articular cartilage, and meniscal abnormalities are easily detected on MRI [13,18,19]. However, meniscal tears are often incidental findings in older patients with the majority of people over 70 years

of age having an asymptomatic meniscal tear, and the likelihood of a meniscal tear being present in either a painful or asymptomatic knee not significantly different in patients 45 to 55 years of age [20,21].

Bone marrow lesions (BML) are readily depicted on MRI as areas of increased edema-like signal in the subchondral bone. New or increasing BMLs are associated with increased knee pain, especially in males or patients with family history of osteoarthritis [22]. Conversely, decreasing BMLs are associated with reduced knee pain [23]. A systematic review of 22 articles concluded that both BMLs and synovitis/effusion may indicate the origin of knee pain in patients with osteoarthritis [24-26].

Subchondral insufficiency fractures, now recognized as the underlying cause of what was previously termed spontaneous osteonecrosis of the knee, most commonly involve the medial femoral condyle in middle-aged to elderly females. MRI can identify subchondral insufficiency fractures earlier than radiographs with radiographs often initially normal [27]. Radiographs may later reveal articular surface fragmentation, subchondral collapse, and progressive osteoarthritis sometimes requiring total knee arthroplasty [27]. Even when a subchondral insufficiency fracture is diagnosed on a conventional radiograph, MRI may be indicated if an additional injury is suspected clinically. MRI can also detect tibial stress fractures as discussed in the ACR Appropriateness Criteria® topic on “[Stress \(Fatigue/Insufficiency\) Fracture, Including Sacrum, Excluding Other Vertebrae](#)” [28].

Some patients with normal knee radiographs and anterior knee pain have abnormal cartilage on 3 T MRI using quantitative imaging [29]. In particular, patients 45 to 55 years of age with knee pain but normal radiographs exhibited elevated T2 mapping values on 3 T MRI [20].

Patellofemoral cartilage loss is also associated with chronic knee pain, with active knee pain correlated with BMLs [30,31]. Similar to CT, MRI can calculate various anatomic measurements associated with patellofemoral subluxation/dislocation and lateral patellofemoral friction syndrome [32-34]. Bone marrow edema in the classic location for patellofemoral dislocation/relocation injuries is also identified by MRI [15]. MRI may also differentiate patients with more severe patellofemoral osteoarthritis who may not benefit from supervised exercise therapy from patients with medial or lateral knee compartment arthritis who might benefit [35].

Other etiologies of chronic anterolateral knee pain diagnosed on MRI include patellar tendinopathy, various fat pad impingement syndromes, Hoffa’s disease, deep infrapatellar bursitis, iliotibial band syndrome, adhesive capsulitis, medial plicae, discoid meniscus, tumors, ganglion cysts, pigmented villonodular synovitis, osteophytes, and osteonecrosis [15,19,36-45].

MRI without and with IV contrast is not usually indicated when initial radiograph is negative or demonstrates a joint effusion. However, contrast-enhanced images may be more accurate in diagnosing other causes of chronic knee pain, such as Hoffa’s disease, deep infrapatellar bursitis, patellofemoral friction syndrome, and adhesive capsulitis [15]. In particular, enhancing synovitis thicker than 2 mm in Hoffa’s fat is correlated with peripatellar pain [46]. Contrast-enhanced MRI is also useful in quantifying the degree of synovitis and in evaluating conditions such as pigmented villonodular synovitis [17,42,47,48].

MR Arthrography Knee

MR arthrography performed with an intra-articular injection of dilute gadolinium solution is typically not indicated as a second examination but rather reserved for patients with known prior meniscal surgery, chondral and osteochondral lesions, and suspected loose bodies [10].

US Knee

US is not often useful as a screening test or a comprehensive examination. It may be appropriate to confirm a suspected effusion and to guide a potential aspiration [10]. US is as accurate in diagnosing a popliteal cyst and detecting cyst rupture when compared to MRI [10]. US is also useful in evaluating medial plicae and following patients with iliotibial band syndrome [17,44].

More recently, shear wave elastography has been used to evaluate female patients with patellofemoral pain by demonstrating reduced contraction ratio in the vastus medialis oblique but not the vastus lateralis muscles [49]. Finally, US can diagnose a cyst and determine the vascularity of a mass [37].

Bone Scan Knee

Radionuclide bone scan is usually not indicated when initial radiograph is negative or demonstrates a joint effusion.

Image-Guided Aspiration Knee

If an aspiration for crystals or atypical/low-grade chronic infection is indicated, it can be facilitated by US or fluoroscopy [10].

Variant 3: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates osteochondritis dissecans (OCD), loose bodies, or history of cartilage or meniscal repair. Next imaging procedure.

Radiography Hip

An ipsilateral hip radiograph is usually not indicated to evaluate patients with osteochondritis dissecans (OCD), loose bodies, or history of cartilage repair.

CT Knee

CT without IV contrast may be indicated to evaluate patients with OCD or a history of cartilage repair, especially to confirm loose bodies or when MRI is not definitive.

CT with IV contrast is not usually indicated to evaluate patients with OCD, loose bodies, or history of cartilage repair.

CT without and with IV contrast is not usually indicated to evaluate patients with OCD, loose bodies, or history of cartilage repair.

CT Arthrography Knee

CT arthrography may be used instead of MRI to evaluate the menisci, articular cartilage, and the presence of loose bodies [16].

MRI Knee

In patients with OCD or subchondral insufficiency fracture on radiographs, MRI without IV contrast may be indicated if an additional injury is suspected clinically or to clarify the status of the overlying articular cartilage [41]. A hyperintense rim or cysts at the osteochondral fragment periphery on MRI are less specific for OCD fragment instability in children compared to adults; however, MRI is still useful to determine the best method of treatment [41,50]. Following cartilage repair, MRI can grade the repair site and even guide the retrograde drilling of the OCD lesion [51-54].

MRI with and without IV contrast is not usually indicated to evaluate patients with OCD, loose bodies, or history of cartilage repair because of the usual larger volume of joint fluid, the lesser degree of synovial invagination, and the longer time required to achieve steady state gadolinium in the joint compared to the shoulder [16].

MR Arthrography Knee

MR arthrography is typically reserved for patients with known prior meniscal surgery, chondral and osteochondral lesions, prior cartilage repair procedures, or suspected loose bodies [10,16].

US Knee

US is not often useful as a screening test or a comprehensive examination. It may be appropriate to localize suspected loose bodies, especially if the loose bodies might be within a popliteal cyst, lateral recess, or suprapatellar recess.

Bone Scan Knee

Radionuclide bone scan is usually not indicated to evaluate patients with OCD, loose bodies, or history of cartilage repair.

Image-Guided Aspiration Knee

Joint aspiration is usually not indicated to evaluate patients with OCD, loose bodies, or history of cartilage repair.

Variant 4: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates degenerative changes or chondrocalcinosis. Next imaging procedure.

Radiography Hip

An ipsilateral hip radiograph is usually not indicated to evaluate patients with osteoarthritis or chondrocalcinosis.

CT Knee

Dual-energy CT without IV contrast may be indicated if gout or mixed crystal disease is a consideration. Otherwise, CT is not commonly used as a diagnostic test to evaluate patients with osteoarthritis or chondrocalcinosis. Limited CT without IV contrast can be used for surgical planning.

CT Arthrography Knee

CT arthrography is not commonly utilized as a second test in patients with arthritis even though CT is the most accurate method for evaluating cartilage abnormalities extending to the articular surface that is due to the high spatial resolution between the contrast and the cartilage [11].

MRI Knee

MRI without IV contrast is not usually indicated in patients for whom radiographs are diagnostic of osteoarthritis unless symptoms are not explained by the radiographic findings (eg, stress fractures) or the appropriate treatment option requires additional imaging [11,19].

Given the increased sensitivity of MRI for osteoarthritis, MRI may be indicated when more accurate or serial cartilage measurements are desired [10,55,56]. In patients >70 years of age, a higher correlation with the “abnormal” knee being painful is present when structural abnormalities are unilateral on either radiographs or MRI. Since bilateral structural abnormalities can be present with primarily unilateral symptoms, the ability to discriminate painful from nonpainful knees is limited [57]. This persists even when using the MRI presence of synovitis or effusion and/or a Kellgren and Lawrence score of ≥ 2 ; findings were reported to be the best discriminators between painful and asymptomatic knees [19].

Patellofemoral cartilage loss is closely associated with chronic knee pain with active knee pain correlated with BMLs [56]. Since MRI is more accurate than physical examination in identifying severe grades of chondromalacia patellae, it may be an appropriate screening tool prior to arthroscopy [58].

MRI with and without IV contrast is indicated when performing semiquantitative assessment of knee osteoarthritis using various scoring systems to include cartilage, synovitis, ligaments, BMLs, and menisci [18]. In obese patients with osteoarthritis on contrast-enhanced images, increased perfusion in Hoffa’s fat is associated with more severe anterior knee pain [59].

MR Arthrography Knee

MR arthrography is usually not indicated to evaluate patients with osteoarthritis or chondrocalcinosis.

US Knee

US is not often useful as a screening test or a comprehensive examination. US can detect synovial pathology, effusions, and cortical erosive changes [11]. Power Doppler US can demonstrate increased synovial blood flow that is associated with knee pain and can demonstrate reduced blood flow, which correlates with reduced knee pain following joint injections [60]. US can also demonstrate meniscal extrusion, a finding that suggests an underlying meniscal tear, and, on occasion, chondrocalcinosis and peripheral meniscal tears [11].

Bone Scan Knee

Radionuclide bone scan is usually not indicated to evaluate patients with chronic knee pain given the low specificity and decreased anatomic resolution compared to CT or MRI [11]. However, it may help distinguish between bone and soft-tissue origins for pain as well as localize pain to one or more joints [11].

Image-Guided Aspiration Knee

If an effusion is present, US- or fluoroscopically guided joint aspiration can be performed for synovial fluid analysis if there is concern for crystal disease or infection. Corticosteroid injections can also be performed as they may result in a 1 to 2 week reduction in synovitis on MRI in two-thirds of patients. MRI also demonstrates a subsequent increase in the synovial volume in approximately 70% of patients that develop recurrent pain [61].

Variation 5: Adult or child greater than or equal to 5 years of age. Chronic knee pain. Initial knee radiograph demonstrates signs of prior osseous injury (ie, Second fracture, tibial spine avulsion, etc). Next imaging procedure.

When associated with acute injury, recommendations are covered in the ACR Appropriateness Criteria® topic on “[Acute Trauma to the Knee](#)” [4].

Radiography Hip

An ipsilateral hip radiograph is usually not indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

CT Knee

CT without IV contrast may be indicated to evaluate the patellofemoral anatomy in the setting of chronic knee pain related to repetitive patellofemoral subluxation, which can be suggested by a small osseous fragment along the medial patellar margin on axial knee radiographs [15]. CT knee without IV contrast may also be useful to confirm a prior osseous injury.

CT with IV contrast is not usually indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

CT without and with IV contrast is not usually indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

CT Arthrography Knee

CT arthrography may be used to evaluate the menisci, articular cartilage, and the presence of loose bodies with reported sensitivities and specificities ranging from 86% to 100% [16,62-64].

MRI Knee

MRI without IV contrast may be indicated when radiographs demonstrate a small osseous fragment along the medial patellar margin or if there is a clinical concern for prior or chronic patellar dislocation-relocation. MRI can assess the integrity of the medial patellofemoral ligament and medial patellar retinaculum, define the extent of cartilage injury, and identify loose bodies [41]. MRI is useful for evaluating Osgood-Schlatter or Sinding-Larsen-Johansson syndrome [41]. If the radiograph suggests prior anterior cruciate ligament injury, MRI can effectively evaluate the menisci, but evaluation for associated cartilage lesions is less useful [65].

MRI without and with IV contrast is not usually indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

MR Arthrography Knee

MR arthrography is usually not indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

US Knee

US is usually not indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

Bone Scan Knee

Radionuclide bone scan is usually not indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

Image-Guided Aspiration Knee

Joint aspiration is usually not indicated to evaluate patients with signs of prior (chronic) osseous knee injury.

Summary of Recommendations

- **Variation 1:** Radiographs of the knee are usually appropriate for the initial imaging of chronic knee pain in patients greater than or equal to 5 years of age.
- **Variation 2:** MRI knee without IV contrast is usually appropriate in patients greater than or equal to 5 years of age with chronic knee pain when initial knee radiographs are normal or demonstrate a joint effusion.
- **Variation 3:** MRI knee without IV contrast is usually appropriate in patients greater than or equal to 5 years of age with chronic knee pain when initial knee radiographs demonstrate OCD, loose bodies, or history of cartilage or meniscal repair.
- **Variation 4:** (1) MRI knee without IV contrast or (2) knee aspiration or (3) CT knee without IV contrast may be appropriate in patients greater than or equal to 5 years of age with chronic knee pain when initial radiographs demonstrate degenerative changes or chondrocalcinosis. While MRI knee without IV contrast may be appropriate more often, knee aspiration and CT knee without IV contrast may be appropriate in specific instances detailed in the narrative. On occasion, these examinations may complement each other with more than one being appropriate.

- **Variation 5:** MRI knee without IV contrast is usually appropriate in patients greater than or equal to 5 years of age with chronic knee pain when initial radiographs demonstrates signs of prior osseous injury (ie, Second fracture, tibial spine avulsion, etc).

Summary of Evidence

Of the 66 references cited in the *ACR Appropriateness Criteria® Chronic Knee Pain* document, 4 are categorized as therapeutic references including 1 well-designed study and 3 good-quality studies. Additionally, 62 references are categorized as diagnostic references including 1 well-designed study, 23 good-quality studies, and 9 quality studies that may have design limitations. There are 29 references that may not be useful as primary evidence.

The 66 references cited in the *ACR Appropriateness Criteria® Chronic Knee Pain* document were published from 2000 to 2018.

Although there are references that report on studies with design limitations, 28 well-designed or good-quality studies provide good evidence.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel’s recommendation. “May be appropriate” is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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 [66].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	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.

References

1. Murphy LB, Moss S, Do BT, et al. Annual Incidence of Knee Symptoms and Four Knee Osteoarthritis Outcomes in the Johnston County Osteoarthritis Project. *Arthritis Care Res (Hoboken)* 2016;68:55-65.
2. George E, Tsipas S, Wozniak G, et al. MRI of the knee and shoulder performed before radiography. *J Am Coll Radiol* 2014;11:1053-8.
3. American College of Radiology. ACR Appropriateness Criteria®: Osteonecrosis of the Hip. Available at: <https://acsearch.acr.org/docs/69420/Narrative/>. Accessed September 30, 2018.
4. American College of Radiology. ACR Appropriateness Criteria®: Acute Trauma to the Knee. Available at: <https://acsearch.acr.org/docs/69419/Narrative/>. Accessed September 30, 2018.
5. Hochman MG, Melenevsky YV, Metter DF, et al. ACR Appropriateness Criteria(R) Imaging After Total Knee Arthroplasty. *J Am Coll Radiol* 2017;14:S421-S48.
6. Kransdorf MJ, Murphey MD, Wessell DE, et al. ACR Appropriateness Criteria® Soft-Tissue Masses. *J Am Coll Radiol* 2018;15:S189-S97.
7. American College of Radiology. ACR Appropriateness Criteria®: Primary Bone Tumors. Available at: <https://acsearch.acr.org/docs/69421/Narrative/>. Accessed September 30, 2018.
8. Jacobson JA, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria(R) Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis. *J Am Coll Radiol* 2017;14:S81-S89.
9. Illingworth KD, El Bitar Y, Siewert K, Scaife SL, El-Amin S, Saleh KJ. Correlation of WOMAC and KOOS scores to tibiofemoral cartilage loss on plain radiography and 3 Tesla MRI: data from the osteoarthritis initiative. *Knee Surg Sports Traumatol Arthrosc* 2014;22:1649-58.
10. Wick MC, Kastlunger M, Weiss RJ. Clinical imaging assessments of knee osteoarthritis in the elderly: a mini-review. *Gerontology* 2014;60:386-94.
11. Hayashi D, Roemer FW, Guermazi A. Imaging for osteoarthritis. *Ann Phys Rehabil Med* 2016;59:161-9.
12. Kinds MB, Marijnissen AC, Bijlsma JW, Boers M, Lafeber FP, Welsing PM. Quantitative radiographic features of early knee osteoarthritis: development over 5 years and relationship with symptoms in the CHECK cohort. *J Rheumatol* 2013;40:58-65.
13. Hayashi D, Xu L, Roemer FW, et al. Detection of osteophytes and subchondral cysts in the knee with use of tomosynthesis. *Radiology* 2012;263:206-15.
14. Haviv B, Bronak S, Thein R. The complexity of pain around the knee in patients with osteoarthritis. *Isr Med Assoc J* 2013;15:178-81.
15. Grando H, Chang EY, Chen KC, Chung CB. MR imaging of extrasynovial inflammation and impingement about the knee. *Magn Reson Imaging Clin N Am* 2014;22:725-41.
16. Kalke RJ, Di Primio GA, Schweitzer ME. MR and CT arthrography of the knee. *Semin Musculoskelet Radiol* 2012;16:57-68.

17. Krasnokutsky S, Belitskaya-Levy I, Bencardino J, et al. Quantitative magnetic resonance imaging evidence of synovial proliferation is associated with radiographic severity of knee osteoarthritis. *Arthritis Rheum* 2011;63:2983-91.
18. Guermazi A, Roemer FW, Haugen IK, Crema MD, Hayashi D. MRI-based semiquantitative scoring of joint pathology in osteoarthritis. *Nat Rev Rheumatol* 2013;9:236-51.
19. Javaid MK, Kiran A, Guermazi A, et al. Individual magnetic resonance imaging and radiographic features of knee osteoarthritis in subjects with unilateral knee pain: the health, aging, and body composition study. *Arthritis Rheum* 2012;64:3246-55.
20. Baum T, Joseph GB, Arulanandan A, et al. Association of magnetic resonance imaging-based knee cartilage T2 measurements and focal knee lesions with knee pain: data from the Osteoarthritis Initiative. *Arthritis Care Res (Hoboken)* 2012;64:248-55.
21. Englund M, Guermazi A, Gale D, et al. Incidental meniscal findings on knee MRI in middle-aged and elderly persons. *N Engl J Med* 2008;359:1108-15.
22. Foong YC, Khan HI, Blizzard L, et al. The clinical significance, natural history and predictors of bone marrow lesion change over eight years. *Arthritis Res Ther* 2014;16:R149.
23. Driban JB, Price L, Lo GH, et al. Evaluation of bone marrow lesion volume as a knee osteoarthritis biomarker--longitudinal relationships with pain and structural changes: data from the Osteoarthritis Initiative. *Arthritis Res Ther* 2013;15:R112.
24. Baert IA, Staes F, Truijzen S, et al. Weak associations between structural changes on MRI and symptoms, function and muscle strength in relation to knee osteoarthritis. *Knee Surg Sports Traumatol Arthrosc* 2014;22:2013-25.
25. Yusuf E, Kortekaas MC, Watt I, Huizinga TW, Kloppenburg M. Do knee abnormalities visualised on MRI explain knee pain in knee osteoarthritis? A systematic review. *Ann Rheum Dis* 2011;70:60-7.
26. Zhang Y, Nevitt M, Niu J, et al. Fluctuation of knee pain and changes in bone marrow lesions, effusions, and synovitis on magnetic resonance imaging. *Arthritis Rheum* 2011;63:691-9.
27. Plett SK, Hackney LA, Heilmeyer U, et al. Femoral condyle insufficiency fractures: associated clinical and morphological findings and impact on outcome. *Skeletal Radiol* 2015;44:1785-94.
28. Bencardino JT, Stone TJ, Roberts CC, et al. ACR Appropriateness Criteria(R) Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae. *J Am Coll Radiol* 2017;14:S293-S306.
29. Thuillier DU, Souza RB, Wu S, Luke A, Li X, Feeley BT. T1rho imaging demonstrates early changes in the lateral patella in patients with patellofemoral pain and maltracking. *Am J Sports Med* 2013;41:1813-8.
30. Schiphof D, van Middelkoop M, de Klerk BM, et al. Crepitus is a first indication of patellofemoral osteoarthritis (and not of tibiofemoral osteoarthritis). *Osteoarthritis Cartilage* 2014;22:631-8.
31. Wang J, Antony B, Zhu Z, et al. Association of patellar bone marrow lesions with knee pain, patellar cartilage defect and patellar cartilage volume loss in older adults: a cohort study. *Osteoarthritis Cartilage* 2015;23:1330-6.
32. Barbier-Brion B, Lerais JM, Aubry S, et al. Magnetic resonance imaging in patellar lateral femoral friction syndrome (PLFFS): prospective case-control study. *Diagn Interv Imaging* 2012;93:e171-82.
33. Monk AP, Doll HA, Gibbons CL, et al. The patho-anatomy of patellofemoral subluxation. *J Bone Joint Surg Br* 2011;93:1341-7.
34. Tuna BK, Semiz-Oysu A, Pekar B, Bukte Y, Hayirlioglu A. The association of patellofemoral joint morphology with chondromalacia patella: a quantitative MRI analysis. *Clin Imaging* 2014;38:495-98.
35. Knoop J, Dekker J, van der Leeden M, et al. Is the severity of knee osteoarthritis on magnetic resonance imaging associated with outcome of exercise therapy? *Arthritis Care Res (Hoboken)* 2014;66:63-8.
36. Al-Hadithy N, Gikas P, Mahapatra AM, Dowd G. Review article: Plica syndrome of the knee. *J Orthop Surg (Hong Kong)* 2011;19:354-8.
37. Dean BJ, Reed DW, Matthews JJ, et al. The management of solitary tumours of Hoffa's fat pad. *Knee* 2011;18:67-70.
38. Hayashi D, Xu L, Guermazi A, et al. Prevalence of MRI-detected mediopatellar plica in subjects with knee pain and the association with MRI-detected patellofemoral cartilage damage and bone marrow lesions: data from the Joints On Glucosamine study. *BMC Musculoskelet Disord* 2013;14:292.
39. Jalgaonkar A, Dachevall S, Farid M, Rao S. Angioleiomyoma of the knee: case series and an unusual cause of knee pain. *J Knee Surg* 2011;24:33-7.
40. Mao Y, Dong Q, Wang Y. Ganglion cysts of the cruciate ligaments: a series of 31 cases and review of the literature. *BMC Musculoskelet Disord* 2012;13:137.

41. Orth RC. The pediatric knee. *Pediatr Radiol* 2013;43 Suppl 1:S90-8.
42. Ottaviani S, Ayral X, Dougados M, Gossec L. Pigmented villonodular synovitis: a retrospective single-center study of 122 cases and review of the literature. *Semin Arthritis Rheum* 2011;40:539-46.
43. Skiadas V, Perdikakis E, Plotas A, Lahanis S. MR imaging of anterior knee pain: a pictorial essay. *Knee Surg Sports Traumatol Arthrosc* 2013;21:294-304.
44. Strauss EJ, Kim S, Calcei JG, Park D. Iliotibial band syndrome: evaluation and management. *J Am Acad Orthop Surg* 2011;19:728-36.
45. Toppi J, Fairley J, Cicuttini FM, et al. Factors associated with magnetic resonance imaging defined patellar tendinopathy in community-based middle-aged women: a prospective cohort study. *BMC Musculoskelet Disord* 2015;16:184.
46. Crema MD, Felson DT, Roemer FW, et al. Peripatellar synovitis: comparison between non-contrast-enhanced and contrast-enhanced MRI and association with pain. The MOST study. *Osteoarthritis Cartilage* 2013;21:413-8.
47. Guermazi A, Roemer FW, Hayashi D, et al. Assessment of synovitis with contrast-enhanced MRI using a whole-joint semiquantitative scoring system in people with, or at high risk of, knee osteoarthritis: the MOST study. *Ann Rheum Dis* 2011;70:805-11.
48. Wenham CY, Balamoody S, Grainger AJ, et al. The responsiveness of novel, dynamic, contrast-enhanced magnetic resonance measures of total knee synovitis after intra-articular corticosteroid for painful osteoarthritis. *Osteoarthritis Cartilage* 2014;22:1614-8.
49. Botanlioglu H, Kantarci F, Kaynak G, et al. Shear wave elastography properties of vastus lateralis and vastus medialis obliquus muscles in normal subjects and female patients with patellofemoral pain syndrome. *Skeletal Radiol* 2013;42:659-66.
50. Kijowski R, Blankenbaker DG, Shinki K, Fine JP, Graf BK, De Smet AA. Juvenile versus adult osteochondritis dissecans of the knee: appropriate MR imaging criteria for instability. *Radiology* 2008;248:571-8.
51. Gelber PE, Batista J, Millan-Billi A, et al. Magnetic resonance evaluation of TruFit(R) plugs for the treatment of osteochondral lesions of the knee shows the poor characteristics of the repair tissue. *Knee* 2014;21:827-32.
52. Ojala R, Kerimaa P, Lakovaara M, et al. MRI-guided percutaneous retrograde drilling of osteochondritis dissecans of the knee. *Skeletal Radiol* 2011;40:765-70.
53. Roemer FW, Guermazi A, Trattnig S, et al. Whole joint MRI assessment of surgical cartilage repair of the knee: cartilage repair osteoarthritis knee score (CROAKS). *Osteoarthritis Cartilage* 2014;22:779-99.
54. Stanish WD, McCormack R, Forriol F, et al. Novel scaffold-based BST-CarGel treatment results in superior cartilage repair compared with microfracture in a randomized controlled trial. *J Bone Joint Surg Am* 2013;95:1640-50.
55. Eckstein F, Collins JE, Nevitt MC, et al. Brief Report: Cartilage Thickness Change as an Imaging Biomarker of Knee Osteoarthritis Progression: Data From the Foundation for the National Institutes of Health Osteoarthritis Biomarkers Consortium. *Arthritis Rheumatol* 2015;67:3184-9.
56. Schiphof D, Oei EH, Hofman A, Waarsing JH, Weinans H, Bierma-Zeinstra SM. Sensitivity and associations with pain and body weight of an MRI definition of knee osteoarthritis compared with radiographic Kellgren and Lawrence criteria: a population-based study in middle-aged females. *Osteoarthritis Cartilage* 2014;22:440-6.
57. Roemer FW, Jarraya M, Kwok CK, et al. Brief report: symmetry of radiographic and MRI-detected structural joint damage in persons with knee pain--the Joints on Glucosamine (JOG) Study. *Osteoarthritis Cartilage* 2015;23:1343-7.
58. Pihlajamaki HK, Kuikka PI, Leppanen VV, Kiuru MJ, Mattila VM. Reliability of clinical findings and magnetic resonance imaging for the diagnosis of chondromalacia patellae. *J Bone Joint Surg Am* 2010;92:927-34.
59. Ballegaard C, Riis RG, Bliddal H, et al. Knee pain and inflammation in the infrapatellar fat pad estimated by conventional and dynamic contrast-enhanced magnetic resonance imaging in obese patients with osteoarthritis: a cross-sectional study. *Osteoarthritis Cartilage* 2014;22:933-40.
60. Keen HI, Hensor EM, Wakefield RJ, Mease PJ, Bingham CO, 3rd, Conaghan PG. Ultrasound assessment of response to intra-articular therapy in osteoarthritis of the knee. *Rheumatology (Oxford)* 2015;54:1385-91.
61. O'Neill TW, Parkes MJ, Maricar N, et al. Synovial tissue volume: a treatment target in knee osteoarthritis (OA). *Ann Rheum Dis* 2016;75:84-90.

62. De Filippo M, Bertellini A, Pogliacomì F, et al. Multidetector computed tomography arthrography of the knee: diagnostic accuracy and indications. *Eur J Radiol* 2009;70:342-51.
63. Vande Berg BC, Lecouvet FE, Poilvache P, Dubuc JE, Maldague B, Malghem J. Anterior cruciate ligament tears and associated meniscal lesions: assessment at dual-detector spiral CT arthrography. *Radiology* 2002;223:403-9.
64. Vande Berg BC, Lecouvet FE, Poilvache P, et al. Dual-detector spiral CT arthrography of the knee: accuracy for detection of meniscal abnormalities and unstable meniscal tears. *Radiology* 2000;216:851-7.
65. Vlychou M, Hantes M, Michalitsis S, Tsezou A, Fezoulidis IV, Malizos K. Chronic anterior cruciate ligament tears and associated meniscal and traumatic cartilage lesions: evaluation with morphological sequences at 3.0 T. *Skeletal Radiol* 2011;40:709-16.
66. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed September 30, 2018.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.