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**American College of Radiology
ACR Appropriateness Criteria®
Chronic Extremity Joint Pain–Suspected Inflammatory Arthritis**

Variant 1: Chronic extremity joint pain. Suspect rheumatoid arthritis.

Radiologic Procedure	Rating	Comments	RRL*
X-ray appendicular skeleton area of interest	9	This procedure is the initial imaging method.	⊕
MRI appendicular skeleton area of interest without IV contrast	7	This procedure complements x-ray.	O
MRI appendicular skeleton area of interest without and with IV contrast	7	This procedure complements x-ray.	O
US appendicular skeleton area of interest	7	This procedure complements x-ray.	O
CT appendicular skeleton area of interest without IV contrast	4		Varies
CT appendicular skeleton area of interest with IV contrast	3		Varies
FDG-PET/CT whole body	2		⊕⊕⊕⊕
Tc-99m bone scan whole body	2		⊕⊕⊕
CT appendicular skeleton area of interest without and with IV contrast	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 extremity joint pain. Suspect seronegative spondyloarthropathy.

Radiologic Procedure	Rating	Comments	RRL*
X-ray appendicular skeleton area of interest	9	This procedure is the initial imaging method.	⊕
MRI appendicular skeleton area of interest without and with IV contrast	7	This procedure complements x-ray.	O
US appendicular skeleton area of interest	7	This procedure complements x-ray.	O
MRI appendicular skeleton area of interest without IV contrast	6		O
CT appendicular skeleton area of interest without IV contrast	4		Varies
CT appendicular skeleton area of interest with IV contrast	3		Varies
FDG-PET/CT whole body	2		⊕⊕⊕⊕
CT appendicular skeleton area of interest without and with IV contrast	1		Varies
Tc-99m bone scan whole body	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 extremity joint pain. Suspect gout.

Radiologic Procedure	Rating	Comments	RRL*
X-ray appendicular skeleton area of interest	9	This procedure is the initial imaging method.	☼
CT appendicular skeleton area of interest without IV contrast	7	This refers specifically to dual-energy CT and complements x-ray.	Varies
US appendicular skeleton area of interest	7	This procedure complements x-ray.	O
MRI appendicular skeleton area of interest without IV contrast	6		O
MRI appendicular skeleton area of interest without and with IV contrast	5		O
CT appendicular skeleton area of interest with IV contrast	1		Varies
CT appendicular skeleton area of interest without and with IV contrast	1		Varies
FDG-PET/CT whole body	1		☼☼☼☼
Tc-99m bone scan whole body	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 extremity joint pain. Suspect calcium pyrophosphate dihydrate disease (pseudogout).

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	This procedure shows characteristic findings.	Varies
CT area of interest without IV contrast	5		Varies
MRI area of interest without IV contrast	5		O
MRI area of interest without and with IV contrast	5		O
US area of interest	5		O
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
FDG-PET/CT whole body	1		☼☼☼☼
Tc-99m bone scan whole body	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 extremity joint pain. Suspect erosive osteoarthritis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	This procedure shows characteristic findings.	Varies
MRI area of interest without IV contrast	5		O
MRI area of interest without and with IV contrast	5		O
US area of interest	5		O
CT area of interest without IV contrast	4		Varies
CT area of interest with IV contrast	1		Varies
CT area of interest without and with IV contrast	1		Varies
FDG-PET/CT whole body	1		☼☼☼☼
Tc-99m bone scan whole body	1		☼☼☼
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

CHRONIC EXTREMITY JOINT PAIN–SUSPECTED INFLAMMATORY ARTHRITIS

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Summary of Literature Review

Introduction/Background

In the evaluation for suspected inflammatory arthritis, it is critical that imaging results are interpreted in the context of clinical and serologic results to add specificity as there is significant overlap of imaging findings amongst the various types of arthritis. In addition, many of the imaging findings at one articulation are not specific for one disease process and do not provide the overall diagnosis; therefore, other factors such as global distribution of joint involvement as well as findings from other imaging modalities remain essential to provide an accurate diagnosis. In general, imaging is used to identify abnormalities of osseous and/or soft tissues that can indicate the presence of a chronic inflammatory arthritis.

Overview of Imaging Modalities

Osseous abnormalities

In addition to joint space narrowing, the osseous abnormalities of the extremities that are assessed include erosions and bone proliferation. Erosions, which appear as cortical discontinuity, may be seen at the margins of synovial joints (rheumatoid arthritis and spondyloarthropathies), periarticular (gout), central (erosive osteoarthritis), and at the enthesis (spondyloarthropathies). Bone proliferation, in the form of periostitis and enthesitis, is a hallmark of the spondyloarthropathies and may occur at any cortical bone, including both tendon and ligament attachments. Imaging of osseous abnormalities typically begins with radiography [1]. Although specific, radiography has somewhat low sensitivity given the degree of overlap of the osseous structures. Multiple radiographic views of a joint are often needed to improve erosion identification, such as the hands (posteroanterior, oblique, lateral, semisupinated) and the sacroiliac joints (angled anteroposterior and oblique). Using computed tomography (CT) as the standard of reference, which is an ideal imaging method to characterize cortical bone abnormalities, radiography has 19% sensitivity, 100% specificity, and 81% accuracy in the diagnosis of erosions of the metacarpophalangeal joints [2]. Another technique called tomosynthesis is similar to conventional tomography and can show more erosions than routine radiography [3].

Ultrasound (US) has been used to evaluate for osseous abnormalities in the setting of chronic inflammatory arthritis as well. Compared with radiography, US has been shown to demonstrate a 6.5-fold increase in number of detected erosions of the metacarpophalangeal joints [4]. However, compared with CT, US was able to identify only 42% of erosions in the metacarpophalangeal joints, with a specificity of 92% and an accuracy of 87% [2]. In addition, the false-positive rate for US in detection of metacarpophalangeal joint erosions has been reported as high as 29% [5]. Regardless, large erosions identified with US at the second and third metacarpophalangeal joints, the distal ulna, and the fifth metatarsophalangeal joint are highly specific for and predictive of rheumatoid arthritis [6].

Magnetic resonance imaging (MRI) can be also used to identify cortical erosions and provide a comprehensive overview of a disease process. Technical factors and image resolution remain important, as imaging parameters

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and slice thickness must be optimized to identify erosions. One study evaluating the wrist in rheumatoid arthritis showed that MRI outperformed radiography in the diagnosis of erosions, with MRI identifying erosions in 45% of patients compared with 15% on radiography [7]. Another study comparing MRI and US with CT showed that sensitivities for diagnosis of erosions were 68% and 42%, respectively [8]. However, a meta-analysis concluded that both US and MRI were of comparable efficacy in the detection of erosions [9].

Soft-tissue abnormalities

The soft-tissue abnormalities of the extremities that are assessed with imaging include synovial hypertrophy, which may involve the recesses of synovial joints, tendon sheaths, and bursae, as well as tophi. Radiography and to a lesser extent CT are insensitive in the evaluation of synovial hypertrophy. However, both US and MRI ideally show synovial hypertrophy and can detect hyperemia and enhancement, respectively, to indicate inflammation and severity of synovitis [10]. Both US and MRI outperform clinical examination in the diagnosis of synovitis [11]. In addition, decreased synovial thickness and decreased hyperemia or enhancement can indicate a positive response to therapy and can guide the decision to continue or change treatment [12]. In the diagnosis of synovitis of the fingers, US has been shown to outperform contrast-enhanced MRI [10]. However, another more recent study has shown that MRI with intravenous gadolinium is more sensitive than US and has a higher diagnostic performance, especially in the early stages of rheumatoid arthritis [13].

With regard to nuclear medicine in the evaluation of inflammatory arthritis, Tc-99m scintigraphy has been shown to be sensitive but not specific in the diagnosis of inflammatory arthritis, but it can detect inflammation and predict cortical erosions [10,14]. When adding single-photon emission CT (SPECT), rheumatoid arthritis could be differentiated from osteoarthritis given the added information from tomographic images [14]. Similarly, fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) positron emission tomography (PET) uptake can be seen at sites of inflammation but can be limited by being nonspecific [14,15].

In the evaluation of the soft tissues in crystal deposition diseases, imaging can also be used to identify intra-articular crystal deposition and chondrocalcinosis, as well as calcification of other structures, such as tendon and capsule, in the setting of calcium pyrophosphate dihydrate disease, or pseudogout. Such calcifications can be visualized by radiography, US, and CT, whereas MRI is less sensitive. With regard to soft-tissue tophi associated with gout, radiography and routine CT may show a tophus as increased opacity and increased attenuation, respectively. Although MRI is sensitive in detection of tophi, US shows characteristic features [16]. Dual-energy CT has been also used to detect and quantify monosodium urate crystals in gout with a high degree of sensitivity and accuracy [17,18]. Imaging-guided joint aspiration and synovial biopsy can also be considered to confirm crystal deposition disease.

Discussion of Imaging Modalities by Variant

Variant 1: Chronic extremity joint pain. Suspect rheumatoid arthritis.

Radiography

The hallmarks of rheumatoid arthritis on radiography include periarticular osteopenia, uniform joint space narrowing, and osseous erosions. Although erosions occur later in the disease course, radiography remains important to identify possible erosions and provide an overview of distribution of disease that involves the extremities, and it is recommended as the initial imaging method [19].

Computed tomography

CT, although more sensitive in detection of erosions compared with radiography and MRI, is not routinely used and is limited in the ability to show synovial hypertrophy and other soft-tissue abnormalities.

Magnetic resonance imaging

MRI with intravenous gadolinium has been shown to be more sensitive compared with US and has a higher diagnostic performance, especially in the early stages of rheumatoid arthritis [13]. However, when comparing MRI and US, the evidence is inconclusive as to which imaging method should be considered for evaluation of rheumatoid arthritis [20]. Both MRI and US outperform clinical evaluation in the detection of inflammation and structural damage and provide prognostic information concerning progression [20]. Imaging findings that predict progression of disease include bone marrow edema and synovitis [19]. The use of intravenous gadolinium is important for detection of synovitis and tenosynovitis but is less important in detection of osseous erosions [21,22].

Ultrasound

US outperforms clinical evaluation in detection of inflammation and structural damage of rheumatoid arthritis [20]. In addition, US provides prognostic information (such as detecting synovitis) that is linked to progression [19]. In evaluation of seronegative inflammatory arthritis with US, the presence of erosions, synovial hypertrophy, and hyperemia on US increase the post-test probability of inflammatory arthritis to 50% to 94% [23]. Mild synovial hypertrophy as an isolated finding is not specific and has limited relevance [24]. In evaluation of the finger joints with US, dorsal evaluation is recommended over palmar [25]. Abbreviated US scanning protocols of the hands, wrists, and feet to improve efficiency have been described [26-28]. When comparing US and MRI, the evidence is inconclusive as to which imaging method should be considered for evaluation of rheumatoid arthritis [20].

FDG-PET/CT

FDG-PET/CT is not routinely used in the evaluation of rheumatoid arthritis.

Bone scan

Bone scans are not routinely used in the evaluation of rheumatoid arthritis.

Variant 2: Chronic extremity joint pain. Suspect seronegative spondyloarthropathy.

Imaging assessment for the seronegative spondyloarthropathies, which include psoriatic arthritis, reactive arthritis, ankylosing spondylitis, and arthritis associated with inflammatory bowel disease, includes the synovial spaces, entheses, and osseous surfaces of the extremities.

Radiography

The findings of spondyloarthropathy related to erosions, enthesitis, and bone proliferation are well characterized by radiography [29,30].

Ultrasound

US can identify synovial hypertrophy and blood flow on color Doppler imaging. Although US may also identify erosions and bone proliferation, US may be insensitive (as portions of osseous structures cannot be imaged) as well as not specific (bone irregularity from many causes may appear similar). US may also show imaging findings associated with enthesitis [31]. An additional finding described at US is increased distance between the nail and distal phalanx in patients with psoriatic arthritis and cutaneous psoriasis with 80% sensitivity and 71% specificity [32].

Computed tomography

CT can be used to show cortical erosions, bone proliferation, and enthesitis but is not routinely used for this indication in the extremities. Soft-tissue abnormalities and synovitis are not well demonstrated.

Magnetic resonance imaging

MRI can show cortical erosions, as well as synovial hypertrophy and other soft-tissue abnormalities, with use of intravenous gadolinium. Cortical irregularity from enthesitis and periostitis may also be seen and can be associated with increased fluid signal; although often nonspecific, the location of findings at the entheses and distribution can suggest the diagnosis of seronegative spondyloarthropathy [31]. Increased fluid signal may also be seen on MRI within the bone marrow subjacent to inflammatory enthesitis and periostitis [33].

FDG-PET/CT

FDG-PET/CT is a sensitive imaging method in detection of enthesitis [31].

Bone scan

Bone scans are not routinely used in the evaluation of spondyloarthropathy.

For suspected seronegative spondyloarthropathy, evaluation of axial skeleton, see the ACR Appropriateness Criteria[®] “[Chronic Back Pain: Suspected Sacroiliitis/Spondyloarthropathy](#)” [34].

Variant 3: Chronic extremity joint pain. Suspect gout.

Radiography

Gout can involve the synovial spaces, showing joint distention due to effusion and synovial hypertrophy. Soft-tissue tophi, if not calcified, may appear nonspecific as focal increased opacity on radiography; however, adjacent characteristic erosions may be identified. Identification of erosions may prove difficult when located where osseous structures overlap.

Ultrasound

At US, intra-articular microtophi, echogenic synovial hypertrophy, and “icing” of the cartilage (the double contour sign) are characteristic [16]. Using US, identification of the double contour sign and soft-tissue tophi results in sensitivities/specificities of 83%/76% and 65%/80%, respectively [35]. US has been shown to outperform clinical assessment in the diagnosis of gout [36]. Although US outperforms radiography in the detection of erosions, limitations exist if an erosion involves an area of bone that is inaccessible to US evaluation [37].

Computed tomography

Soft-tissue tophi, if not calcified, appear as focal increased attenuation on CT (160–170 Hounsfield units), often associated with a tendon or adjacent erosion [38]. CT demonstrates characteristic osseous erosions and can show bone involvement in areas that are difficult to evaluate with radiography. Dual-energy CT has been used to show monosodium urate deposition with a sensitivity of 87% and specificity of 84% [35]. However, dual-energy CT has been reported as inaccurate when evaluating the shoulder and hip [16]. Dual-energy CT outperforms clinical assessment in the diagnosis of gout [36].

Magnetic resonance imaging

MRI can be used to demonstrate soft-tissue tophi with 63% sensitivity and 98% specificity in the diagnosis of chronic gouty arthropathy [39]. MRI is more sensitive than US in detection of erosions, and both outperform radiography [37].

FDG-PET/CT

FDG-PET/CT is not routinely used in the evaluation of gout.

Bone scan

Bone scans are not routinely used in the evaluation of gout.

Variant 4: Chronic extremity joint pain. Suspect calcium pyrophosphate dihydrate disease (pseudogout).

Radiography

The hallmark of pseudogout is soft-tissue calcification in the form of chondrocalcinosis, as well as tendon, ligament, and capsular calcification [40]. Radiography can be effective in demonstrating such calcifications in the extremities. Target sites to evaluate for fibrocartilage chondrocalcinosis include the triangular fibrocartilage of the wrists, the menisci of the knees, and the symphysis pubis and labrum at the pelvis, whereas involvement of the hyaline cartilage may occur at any joint. The osseous changes from associated arthropathy characteristically involve the radiocarpal, metacarpophalangeal, and patellofemoral joints and are well demonstrated by radiography [41].

Computed tomography

CT can identify chondrocalcinosis and calcification of tendons, ligaments, and joint capsules. The osseous changes related to pseudogout, such as arthropathy characteristically involving the radiocarpal, metacarpophalangeal, atlantoaxial, and patellofemoral joints, are also well demonstrated by CT [41].

Magnetic resonance imaging

MRI can demonstrate chondrocalcinosis with a higher sensitivity than radiography when using gradient-recalled echo sequences [42]. MRI with intravenous gadolinium may also show synovial hypertrophy if present. The osseous changes related to pseudogout, such as arthropathy characteristically involving the radiocarpal, metacarpophalangeal, and patellofemoral joints, are well demonstrated by MRI.

Ultrasound

US may show soft-tissue calcification as well as synovial hypertrophy. In the knee, the sensitivity/specificity in identification of calcium pyrophosphate dihydrate crystal deposition within the fibrocartilage and hyaline cartilage by US is reported as 90.5%/100% and 59%/100%, respectively, outperforming radiography [43].

FDG-PET/CT

FDG-PET/CT is not routinely used in the evaluation of calcium pyrophosphate crystal deposition disease.

Bone scan

Bone scans are not routinely used in the evaluation of calcium pyrophosphate crystal deposition disease.

Variant 5: Chronic extremity joint pain. Suspect erosive osteoarthritis.

Radiography

The characteristic central erosions involving the interphalangeal joints are well demonstrated by radiography [44].

Computed tomography

Similar to radiographs, the central erosions involving the interphalangeal joints are also demonstrated by CT [44].

Ultrasound

Although US may show synovial hypertrophy and marginal osteophytes, the characteristic central erosion of the interphalangeal joint is not visible. Both US and contrast-enhanced MRI have been shown to perform equally in the demonstration of synovitis of the fingers associated with erosive osteoarthritis [45].

Magnetic resonance imaging

MRI can show the features of erosive osteoarthritis, although the findings may be nonspecific, potentially mimicking other types of joint inflammation. Both US and contrast-enhanced MRI have been shown to perform equally in the demonstration of synovitis of the fingers associated with erosive osteoarthritis [45].

FDG-PET/CT

FDG-PET/CT is not routinely used in the evaluation of erosive osteoarthritis.

Bone scan

Bone scans are not routinely used in the evaluation of erosive osteoarthritis.

Summary of Recommendations

- Variant 1 (rheumatoid arthritis): Radiography should be the initial imaging method, often showing characteristic disease distribution and imaging findings. Both ultrasound and MRI complement radiography by showing synovitis and identifying additional erosions, although MRI may outperform ultrasound in early disease.
- Variant 2 (seronegative spondyloarthropathy): Radiography should be the initial imaging method, often showing characteristic osseous findings. Both ultrasound and MRI complement radiography by showing synovitis and identifying additional erosions.
- Variant 3 (gout): Radiography should be the initial imaging method as imaging findings are often characteristic. Both ultrasound and CT, including dual-energy CT, complement radiography in the detection of erosions and tophi.
- Variant 4 (pseudogout): Radiography should be the initial imaging method, often showing characteristic disease distribution and calcification. Both ultrasound and gradient-recalled echo MRI outperform radiography for chondrocalcinosis detection and complement radiography by showing synovitis and additional osseous findings.
- Variant 5 (erosive osteoarthritis): Radiography should be the initial imaging method, showing characteristic imaging findings. Both ultrasound and MRI complement radiography by showing synovitis.

Summary of Evidence

Of the 45 references cited in the *ACR Appropriateness Criteria® Chronic Extremity Joint Pain–Suspected Inflammatory Arthritis* document, all are categorized as diagnostic references, including 5 well-designed studies, 10 good-quality studies, and 9 quality studies that may have design limitations. There are 19 references that may not be useful as primary evidence. There are 2 references that are meta-analysis studies.

The 45 references cited in the *ACR Appropriateness Criteria® Chronic Extremity Joint Pain–Suspected Inflammatory Arthritis* document were published from 1998 to 2016.

Although there are references that report on studies with design limitations, 15 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
○	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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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.