American College of Radiology
ACR Appropriateness Criteria®
Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis

Variant 1: **Chronic extremity joint pain. Suspect inflammatory (seropositive or seronegative arthritis), crystalline (gout or pseudogout), or erosive osteoarthritis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography area of interest	Usually Appropriate	Varies
US area of interest	Usually Not Appropriate	O
MRI area of interest without and with IV contrast	Usually Not Appropriate	O
MRI area of interest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
CT area of interest with IV contrast	Usually Not Appropriate	Varies
CT area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT area of interest without IV contrast	Usually Not Appropriate	Varies

Variant 2: **Chronic extremity joint pain. Suspect inflammatory arthritis (seropositive or seronegative arthritis). Radiographs normal or inconclusive. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US area of interest	Usually Appropriate	O
MRI area of interest without and with IV contrast	Usually Appropriate	O
MRI area of interest without IV contrast	Usually Appropriate	O
Image-guided aspiration area of interest	Usually Not Appropriate	Varies
Bone scan whole body	Usually Not Appropriate	☢☢☢
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
CT area of interest with IV contrast	Usually Not Appropriate	Varies
CT area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT area of interest without IV contrast	Usually Not Appropriate	Varies

Variant 3: **Chronic extremity joint pain. Suspect gout. Radiographs normal or inconclusive. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US area of interest	Usually Appropriate	O
CT area of interest without IV contrast	Usually Appropriate	Varies
Image-guided aspiration area of interest	May Be Appropriate	Varies
MRI area of interest without and with IV contrast	Usually Not Appropriate	O
MRI area of interest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
CT area of interest with IV contrast	Usually Not Appropriate	Varies
CT area of interest without and with IV contrast	Usually Not Appropriate	Varies

Variant 4: **Chronic extremity joint pain. Suspect calcium pyrophosphate deposition disease (pseudogout). Radiographs normal or inconclusive. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US area of interest	Usually Appropriate	O
CT area of interest without IV contrast	Usually Appropriate	Varies
Image-guided aspiration area of interest	May Be Appropriate	Varies
MRI area of interest without and with IV contrast	Usually Not Appropriate	O
MRI area of interest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
CT area of interest with IV contrast	Usually Not Appropriate	Varies
CT area of interest without and with IV contrast	Usually Not Appropriate	Varies

Variant 5: **Chronic extremity joint pain. Suspect erosive osteoarthritis. Radiographs normal or inconclusive. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US area of interest	May Be Appropriate	O
MRI area of interest without and with IV contrast	May Be Appropriate	O
Image-guided aspiration area of interest	Usually Not Appropriate	Varies
MRI area of interest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
CT area of interest with IV contrast	Usually Not Appropriate	Varies
CT area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT area of interest without IV contrast	Usually Not Appropriate	Varies

Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis

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Summary of Literature Review

Introduction/Background

Types of nondegenerative arthritides resulting in chronic extremity pain can be broadly divided into seropositive inflammatory arthritis, seronegative inflammatory arthritis (spondyloarthritis), and crystalline arthritis. Although erosive osteoarthritis is often classified as a subset of osteoarthritis [1], the severity of clinical symptoms often put it in the realm of inflammatory arthritis in terms of differential diagnosis. Although it is much less common than osteoarthritis, millions of Americans suffer from chronic extremity pain from inflammatory and crystalline arthropathies. The prevalence of rheumatoid arthritis (RA), the most common inflammatory arthritis, has been reported to be between 0.5% and 1% [2], and the prevalence of gout, the most common crystalline arthritis, is as high as 3.9% of adults in the United States [3]. Imaging plays an important role in the diagnosis and management of inflammatory and crystalline arthritis. It is important to consider global distribution of skeletal involvement, and correlating findings on multiple studies/modalities may be necessary. Furthermore, it is critical that imaging results are interpreted in the context of clinical and serologic results to add specificity because there is significant overlap of imaging findings amongst the various types of arthritis.

Imaging can be used to identify osseous and/or soft tissues abnormalities that are seen with inflammatory and crystalline arthritis. In addition to joint space narrowing, the osseous abnormalities of the extremities that are assessed include erosions, bone proliferation in the form of enthesitis and periostitis, and bone marrow edema. The location of the erosions with respect to the joint (ie, marginal, para-articular, central, and subenethesial) is helpful in differential diagnosis. Bone proliferation, in the form of enthesitis, is a hallmark of spondyloarthropathies and may occur at any cortical bone, including both tendon and ligament attachments. Soft tissue abnormalities of the extremities that are assessed with imaging include soft tissue crystal deposition and synovial hypertrophy, which may be intraarticular or involve tendon sheaths and bursae.

This document discusses 5 variants: 1) Chronic extremity joint pain. Suspect inflammatory (seropositive or seronegative arthritis), crystalline (gout or pseudogout), or erosive osteoarthritis. Initial imaging. 2) Chronic extremity joint pain. Suspect inflammatory arthritis (seropositive or seronegative arthritis). Radiographs normal or inconclusive. Next imaging study. 3) Chronic extremity joint pain. Suspect gout. Radiographs normal or inconclusive. Next imaging study. 4) Chronic extremity joint pain. Suspect calcium pyrophosphate (CPP) dihydrate disease (pseudogout). Radiographs normal or inconclusive. Next imaging study. 5) Chronic extremity joint pain. Suspect erosive osteoarthritis. Radiographs normal or inconclusive. Next imaging study.

The body regions covered in this topic are the joints of the appendicular skeleton including ankle, elbow, foot, hand, hip, knee, shoulder, and wrist. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information. Many of these arthritides can also involve the axial skeleton. The approach to axial spondyloarthropathy is; however, discussed separately in the ACR Appropriateness Criteria® topic on "Inflammatory Back Pain: Known or Suspected Axial Spondyloarthropathy" [4]. For details on appropriate imaging workup of chronic joint pain related to infectious etiologies, please refer to

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ACR Appropriateness Criteria® topic on "Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot)" [5].

Special Imaging Considerations

Image-guided aspiration may be helpful in confirming and characterizing crystal deposition disease and excluding infection. Image-guided aspiration may be challenging; however, depending on the amount of fluid present [6,7].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Chronic extremity joint pain. Suspect inflammatory (seropositive or seronegative arthritis), crystalline (gout or pseudogout), or erosive osteoarthritis. Initial imaging.

The area of interest for this variant include: the ankle, elbow, foot, hand, hip, knee, shoulder, and wrist.

Bone Scan Whole Body

There is no relevant literature supporting the use of bone scan whole body as the initial imaging modality in this clinical scenario.

CT Area of Interest With IV Contrast

There is no relevant literature supporting the use of CT area of interest with intravenous (IV) contrast as the initial imaging modality in this clinical scenario.

CT Area of Interest Without and With IV Contrast

There is no relevant literature supporting the use of CT area of interest without and with IV contrast as the initial imaging modality in this clinical scenario.

CT Area of Interest Without IV Contrast

There is no relevant literature supporting the use of CT area of interest without IV contrast as the initial imaging modality in this clinical scenario.

FDG-PET/CT Whole Body

There is no relevant literature supporting the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT whole body as the initial imaging modality in this clinical scenario.

MRI Area of Interest Without and With IV Contrast

There is no relevant literature supporting the use of MRI area of interest without and with IV contrast as the initial imaging modality in this clinical scenario.

MRI Area of Interest Without IV Contrast

There is no relevant literature supporting the use of MRI area of interest without IV contrast as the initial imaging modality in this clinical scenario.

Radiography Area of Interest

Radiographs are beneficial as the initial imaging study for chronic extremity joint pain where inflammatory arthritis, crystalline arthritis, or erosive osteoarthritis is suspected. Radiography has a low sensitivity compared with other modalities including CT, MRI, US, and tomosynthesis [8-12] for the detection of erosions, and multiple radiographic views of a joint are often needed to improve erosion identification. Nevertheless, the location and distribution of osseous erosions and/or productive change are often adequate for diagnosis. Other causes of pain such as osteoarthritis, infection, and trauma may also be apparent. Thus, radiographs potentially avoid the need for further workup and delays in treatment. Even in the case of RA, in which early treatment is associated with improved

outcomes, the 2013 European League Against Rheumatism (EULAR) guidelines on imaging of the joints in RA recommends radiographs of the hand and feet as the initial imaging technique [13]. Assessment for synovitis and tenosynovitis is limited on radiography, although soft tissue swelling can be seen in the affected regions. Soft tissue and intraarticular crystal deposition as seen with gout or CPP deposition (CPPD); however, are readily apparent on radiographs in the form of tophi and chondrocalcinosis, respectively.

US Area of Interest
There is no relevant literature supporting the use of ultrasound (US) area of interest as the initial imaging modality in this clinical scenario.

Variant 2: Chronic extremity joint pain. Suspect inflammatory arthritis (seropositive or seronegative arthritis). Radiographs normal or inconclusive. Next imaging study.

Seropositive (rheumatoid) arthritis and seronegative spondyloarthritides including psoriatic arthritis, ankylosing spondylitis, reactive arthritis, and arthritis associated with inflammatory bowel disease share many clinical, pathologic, and imaging similarities. Thus, a uniform approach in the imaging workup of these entities is reasonable. Features of osseous erosions and soft tissue findings of synovitis and tenosynovitis may be seen in both seropositive and seronegative inflammatory arthritis, whereas enthesitis and dactylitis are typically seen only with the spondyloarthritis.

The area of interest for this variant include: the ankle, elbow, foot, hand, hip, knee, shoulder, and wrist.

Bone Scan Whole Body
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 [9,14]. There is insufficient evidence to support routine use of bone scans for evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs.

Bone Scan Whole Body with SPECT or SPECT/CT Area of Interest
When adding single-photon emission CT (SPECT), RA could be differentiated from osteoarthritis given the added information from tomographic images [14]. There is insufficient evidence to support routine use of bone scans with SPECT or SPECT/CT for evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs.

CT Area of Interest With IV Contrast
There is insufficient evidence to support the routine use of CT area of interest with IV contrast for the evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs. Although CT can show bony erosions and productive changes with high diagnostic confidence, the ability of CT to identify and characterize associated inflammatory soft tissue findings and bone marrow edema is limited. Newer techniques of iodine-dual-energy CT (DECT) mapping and high-resolution peripheral quantitative CT have shown promise in detection and quantification of periarticular/tenosynovial inflammation and bony changes respectively [15]. Further validation is needed; however, and these techniques are not widely used in clinical practice.

CT Area of Interest Without and With IV Contrast
There is insufficient evidence to support routine use of CT area of interest without and with IV for the evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs. As mentioned before, although CT can show bony erosions and productive changes with high diagnostic confidence, the ability of CT to identify and characterize associated inflammatory soft tissue findings and bone marrow edema is limited. Newer techniques of iodine-DECT mapping and high-resolution peripheral quantitative CT have shown promise in detection and quantification of periarticular/tenosynovial inflammation and bony changes, respectively [15]. Further validation is needed; however, and these techniques are not widely used in clinical practice.

CT Area of Interest Without IV Contrast
There is insufficient evidence to support the routine use of CT area of interest without IV contrast for the evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs. As mentioned before, although CT can show bony erosions and productive changes with high diagnostic confidence, the ability of CT to identify and characterize associated inflammatory soft tissue findings and bone marrow edema is limited.

FDG-PET/CT Whole Body
FDG-PET uptake can be seen at sites of inflammation but is limited by being nonspecific [14,16]. Novel PET tracers targeting specific immunological targets in RA have been described but only tested preclinically or in small patient cohorts [17]. Further research is needed to validate these early results and determine their clinical role, if any. The literature suggests that PET/CT studies are not routinely obtained for evaluation of seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs.

Image-Guided Aspiration Area of Interest
Image-guided aspiration is generally not useful in the seropositive or seronegative inflammatory arthritis in the extremities following initial radiographs. Image-guided aspiration may be helpful in excluding crystal deposition disease and infection.

MRI Area of Interest Without and With IV Contrast
Regarding the diagnosis of RA, the 2013 EULAR task force recommendations on use of imaging of the joints in RA state that when there is diagnostic doubt following radiographs, either US or MRI can be used to improve certainty of diagnosis of RA above clinical criteria as well as to detect early joint damage before it is radiographically visible [13]. Both MRI and US outperform clinical evaluation in the detection of inflammation and structural damage and provide prognostic information concerning radiographic progression [18-20]. The evidence is inconclusive as to whether MRI or US should be considered the preferred method for evaluation of RA [18]. However, MRI with IV gadolinium contrast has been shown to be more sensitive compared with US in the early stages of RA [21] and aids in detection of synovitis and tenosynovitis [22,23]. Therefore, when safe to do so, MRI of the area of interest should ideally be performed without and with IV contrast.

MRI area of interest without IV contrast can show cortical erosions, bone edema, synovial hypertrophy, and soft tissue abnormalities such as tenosynovitis and dactylitis. The use of IV gadolinium is less important in the detection of osseous erosions and bone edema but enhances detection of synovitis and tenosynovitis [22,23]. Cortical irregularity from inflammatory enthesitis and periostitis and increased fluid signal in the subjacent bone marrow may be seen on MRI without IV contrast [24]. Entheseal involvement in a characteristic distribution can suggest the diagnosis of seronegative spondyloarthropathy [25]. MRI-detected erosions as defined by the Rheumatoid Arthritis MRI Scoring System (RAMRIS) criteria [26] can be observed in the metacarpophalangeal and metatarsophalangeal joints of symptom-free individuals in the general population and in different types of rheumatologic diseases and are thus nonspecific [27]. Although synovial hypertrophy can be appreciated on unenhanced sequences, the use of IV gadolinium aids in the evaluation of synovitis because it helps differentiate joint effusion from synovium, which may demonstrate similar signal characteristics on unenhanced sequences [23,28].

MRI Area of Interest Without IV Contrast
Regarding the diagnosis of RA, the 2013 EULAR task force recommendations on the use of imaging of the joints in RA state that when there is diagnostic doubt following radiographs, either US or MRI can be used to improve certainty of diagnosis of RA above clinical criteria as well as to detect early joint damage before it is radiographically visible [13]. Both MRI and US outperform clinical evaluation in the detection of inflammation and structural damage and provide prognostic information concerning radiographic progression [18-20]. The evidence is inconclusive as to whether MRI or US should be considered the preferred method for evaluation of RA [18].

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US Area of Interest
As mentioned before, the 2013 EULAR task force recommendations on use of imaging of the joints in RA state that when there is diagnostic doubt following radiographs, US, or MRI can be used to improve the certainty of diagnosis of RA above clinical criteria as well as to detect early joint damage before it is radiographically visible [13]. Although MRI with IV contrast has been shown to be more sensitive compared with US and has higher diagnostic performance [21], both outperform clinical evaluation and provide prognostic information concerning

radiographic progression [10-12]. The evidence is inconclusive as to whether MRI or US should be considered the preferred method for evaluation of RA [18].

US has been used to evaluate for osseous abnormalities in the setting of chronic inflammatory arthritis. Compared with radiography, US has been shown to demonstrate a 6.5-fold increase in the number of detected erosions of the metacarpophalangeal joints [12], but it is less accurate when compared with CT [11]. The false-positive rate for US in detection of metacarpophalangeal joint erosions has been reported as high as 29% [29]. 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 RA [30]. US may also show imaging findings associated with enthesitis [25], with findings of enthesitis on power Doppler imaging having an accuracy of 85.6% in distinguishing peripheral spondyloarthritis versus nonspondyloarthropathy [31]. Studies have also found US to be helpful in differentiating RA and psoriatic arthritis [32,33]; for example, enthesitis is a finding often seen in spondyloarthritis but not seen in RA. Increased distance between the nail and distal phalanx in patients with psoriatic arthritis and cutaneous psoriasis is reported to have an 80% sensitivity and a 71% specificity [34].

US is also useful in the evaluation for synovitis and tenosynovitis, aided by the detection of hyperemia via color or Doppler signal [23]. Power Doppler US is more accurate for the diagnosis of synovitis and has a higher correlation with disease activity compared with grayscale US [35,36]. Synovitis on power Doppler US and grayscale US are both associated with the development of radiographic erosions in patients with RA compared with grayscale US [37,38]. Newer techniques for detecting microvascularization associated with joint inflammation like multimodal photoacoustic/US and ultra-microangiography have shown promise as indicators of disease activity [39,40].

US also provides prognostic information (such as detecting synovitis) that is linked to disease progression [13], although mild synovial hypertrophy as an isolated finding is not specific and has limited relevance [41]. In the evaluation of the finger joints with US, dorsal evaluation is recommended over palmar [42]. Abbreviated US scanning protocols of the hands, wrists, and feet to improve efficiency have been described [43-46].

Variant 3: Chronic extremity joint pain. Suspect gout. Radiographs normal or inconclusive. Next imaging study.

The area of interest for this variant include: the ankle, elbow, foot, hand, hip, knee, shoulder, and wrist.

Bone Scan Whole Body

There is no relevant literature supporting the use of bone scan whole body for the evaluation of gout in the extremities following initial radiographs.

CT Area of Interest With IV Contrast

There is no relevant literature supporting the use of CT area of interest with IV contrast for the evaluation of gout in the extremities following initial radiographs.

CT Area of Interest Without and With IV Contrast

There is no relevant literature supporting the use of CT area of interest without and with IV for the evaluation of gout in the extremities following initial radiographs.

CT Area of Interest Without IV Contrast

DECT allows visualization of monosodium urate deposition with a sensitivity ranging from 81% to 88% and a specificity ranging from 90% to 93% [47-49]. However, DECT is less accurate in early stages of gout, with a sensitivity in initial stages of gout flare (<6 weeks) ranging between 36% and 80% [15,47]. Sensitivity is also low for deeper structures such as the shoulder and hip [16]. DECT outperforms clinical assessment in the diagnosis of gout [50] and has been shown to be more sensitive for the diagnosis of gout compared to US in studies of patients in mixed stages of disease [51-53]. DECT has been shown to be helpful in assessment of tophus resolution in response to treatment [54].

Although conventional CT area of interest without IV contrast can show characteristic osseous erosions and soft tissue tophi [38], the 2018 EULAR recommendations state that conventional CT without IV contrast has limited utility for diagnosis of gout compared with US and DECT [55]. However, for the purposes of this document, DECT is considered a technique categorized under this procedure subheading.

FDG-PET/CT Whole Body

There is no relevant literature supporting the use of FDG-PET/CT whole body for the evaluation of gout in the extremities following initial radiographs.

Image-Guided Aspiration Area of Interest
Image-guided aspiration may be helpful in confirming and characterizing crystal deposition disease and excluding infection. The identification of urate crystals in the aspirate is diagnostic of gout. If urate crystals are not seen in the aspirate; however, this does not necessarily exclude gout. Up to 16% patients diagnosed with acute gout can have negative aspirates [56].

MRI Area of Interest Without and With IV Contrast
MRI can show the presence of tophi, crystal induced synovitis, and joint damage [57]; however, the 2018 EULAR recommendations state that MRI has limited utility for diagnosis of gout compared with US and DECT. MRI with or without IV contrast is not supported for routine evaluation of gout in the extremities following initial radiographs [55].

MRI Area of Interest Without IV Contrast
MRI can show the presence of tophi, crystal induced synovitis, and joint damage [57]; however, the 2018 EULAR recommendations state that MRI has limited utility for diagnosis of gout compared with US and DECT. MRI without IV contrast is not supported for routine evaluation of gout in the extremities following initial radiographs [55].

US Area of Interest
The 2018 EULAR recommendations favor US over other modalities [55]. The Outcome Measures in Rheumatology definitions of US elementary lesions in gout include double contour sign, tophus, aggregates, and erosions [58]. Identification of the double contour sign and soft tissue tophi are highly sensitive, specific, and accurate for the diagnosis of gout [59,60], with double contour sign having excellent reliability [61]. US has been shown to outperform clinical assessment in the diagnosis of gout [50] and outperforms radiography in the detection of erosions, although limitations exist if an erosion involves an area of bone that is inaccessible to US evaluation [62]. There is evidence that US may have higher sensitivity for detection of gout compared with DECT in early gout (duration <1 year) [63]. US has also been shown to be helpful in assessment of tophus resolution in response to treatment [64,65].

Variant 4: Chronic extremity joint pain. Suspect calcium pyrophosphate deposition disease (pseudogout). Radiographs normal or inconclusive. Next imaging study.

The EULAR defines CPPD as a general term encompassing variable phenotypes, including asymptomatic involvement, acute CPP crystal arthritis, osteoarthritis with CPPD, and chronic CPP crystal inflammatory arthritis [66]. CPPD is thought to have high prevalence in the elderly [67] but is underdiagnosed. CPPD joint involvement as defined by EULAR is when CPP is detected in the synovial fluid from affected joints [66]. Diagnosis is often challenging; however, because the reference standard of synovial fluid analysis has been shown to have a high specificity (100%) but a lower sensitivity (75%) [68]. Chondrocalcinosis is defined as cartilage calcification detected by imaging or histological examination and is most commonly due to CPPD. However, the relationship between chondrocalcinosis and commonly coexisting conditions like osteoarthritis and hemochromatosis is poorly understood.

The area of interest for this variant include: the ankle, elbow, foot, hand, hip, knee, shoulder, and wrist.

Bone Scan Whole Body
There is no relevant literature supporting the use of bone scan whole body for the evaluation of CPPD in the extremities following initial radiographs.

CT Area of Interest With IV Contrast
There is no relevant literature supporting the use of CT area of interest with IV contrast for the evaluation of CPPD in the extremities following initial radiographs.

CT Area of Interest Without and With IV Contrast
There is no relevant literature supporting the use of CT area of interest without and with IV for the evaluation of CPPD in the extremities following initial radiographs.

CT Area of Interest Without IV Contrast
CT without IV contrast can identify chondrocalcinosis and mineralization of tendons, ligaments, and joint capsules as well as show that osseous changes related to CPPD, such as arthropathy characteristically involving the radiocarpal, metacarpophalangeal, atlantoaxial, and patellofemoral joints, are also well demonstrated by CT [69].

Both conventional CT without IV contrast and DECT have similarly high sensitivity for the detection of chondrocalcinosis [69-71]. DECT combines the information offered by conventional CT and adds information about the molecular compositions of the tissues. Therefore, the potential advantage of DECT over conventional CT is not an increased sensitivity but the ability to characterize (for example in distinguishing gout and pseudogout) and quantify crystal deposition. For the purposes of this document, DECT is considered a technique categorized under this procedure subheading.

FDG-PET/CT Whole Body
There is no relevant literature supporting the use of FDG-PET/CT whole body for the evaluation of CPPD in the extremities following initial radiographs.

Image-Guided Aspiration Area of Interest
Image-guided aspiration may be helpful in confirming and characterizing crystal deposition disease and excluding infection [68]. Diagnosis is often challenging; however, because the reference standard of synovial fluid analysis has been shown to have a high specificity (100%) but a lower sensitivity (75%) [68].

MRI Area of Interest Without and With IV Contrast
Chondrocalcinosis may be seen as foci of low signal on MRI, and detection may be improved on gradient echo and ultra-short time to echo sequences [72]. Future research is needed to determine the role of MRI in the evaluation of CPPD in the extremities. There is insufficient evidence to support routine use of MRI with or without IV contrast in the diagnosis of CPPD.

MRI Area of Interest Without IV Contrast
Chondrocalcinosis may be seen as foci of low signal on MRI, and detection may be improved on gradient echo and ultra-short time to echo sequences [72]. Future research is needed to determine the role of MRI in the evaluation of CPPD in the extremities. There is insufficient evidence to support routine use of MRI without IV contrast in the diagnosis of CPPD.

US Area of Interest
CPPD can be seen as echogenic foci in in hyaline cartilage, tendons, and the menisci. US has been shown to outperform radiography in detection of chondrocalcinosis [73,74]. Filippou et al [75] found that US had an overall diagnostic accuracy of 75%, with a sensitivity of 91% and a specificity of 59% with histology as the reference standard. The positive predicative value and negative predicative value were 88% and 76%, respectively. When considering combination of medial meniscus and medial condyle hyaline cartilage in combination, US has a sensitivity and specificity of 88% and 76%, respectively.

Variant 5: Chronic extremity joint pain. Suspect erosive osteoarthritis. Radiographs normal or inconclusive. Next imaging study.

Bone Scan Whole Body
There is no relevant literature supporting the use of bone scan whole body for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

CT Area of Interest With IV Contrast
There is no relevant literature supporting the use of CT area of interest with IV contrast for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

CT Area of Interest Without and With IV Contrast
There is no relevant literature supporting the use of CT area of interest without and with IV contrast for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

CT Area of Interest Without IV Contrast
Although CT is well-suited for demonstration of osseous erosions, there is no relevant literature supporting the use of CT area of interest without IV contrast for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

FDG-PET/CT Whole Body
There is no relevant literature supporting the use of FDG-PET/CT whole body for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

Image-Guided Aspiration Area of Interest
There is no relevant literature supporting the use of image-guided aspiration for the evaluation of erosive osteoarthritis in the extremities following initial radiographs.

MRI Area of Interest Without and With IV Contrast
MRI can show the features of erosive osteoarthritis, although the findings may be nonspecific, potentially mimicking other types of joint inflammation. The addition of IV contrast may aid in the differentiation of synovitis from joint effusion [23].

MRI Area of Interest Without IV Contrast
MRI can show the features of erosive osteoarthritis, although the findings may be nonspecific, potentially mimicking other types of joint inflammation.

US Area of Interest
US may demonstrate synovial hypertrophy, marginal osteophytes, and central erosions [76] but is not routinely used in clinical practice for the evaluation of erosive osteoarthritis. Both US and contrast-enhanced MRI have been shown to perform equally in the demonstration of synovitis of the fingers associated with erosive osteoarthritis [76]. However, synovitis on US is nonspecific and may be seen with erosive osteoarthritis and inflammatory arthritis.

Summary of Recommendations

- **Variant 1**: Radiography is usually appropriate as the initial imaging of chronic extremity joint pain for suspected inflammatory (seropositive or seronegative arthritis), crystalline (gout or pseudogout), or erosive osteoarthritis.
- **Variant 2**: In the setting of chronic extremity joint pain with normal or inconclusive radiographs, US or MRI without and with IV contrast or MRI without IV contrast is usually appropriate as the next imaging study for suspected inflammatory arthritis (seropositive or seronegative arthritis). These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 3**: In the setting of chronic extremity joint pain with normal or inconclusive radiographs, US or CT without IV contrast (specifically DECT) is usually appropriate as the next imaging study for suspected gout. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 4**: In the setting of chronic extremity joint pain with normal or inconclusive radiographs, US or CT without IV contrast (including DECT) is usually appropriate as the next imaging study for suspected CPP dihydrate disease (pseudogout). These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 5**: In the setting of chronic extremity joint pain with normal or inconclusive radiographs, US or MRI without and with IV contrast may be appropriate as the next imaging study for suspected CPP dihydrate disease (pseudogout).

Supporting Documents
The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

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

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, because of both 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 with 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 [77].

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."		

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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.