Effective Date: 09/10/2023 **Version Creation Date: 01/24/2023**

Approval and implementation dates for specific health plans may vary. Please consult the applicable health plan for more details.

CLINICAL APPROPRIATENESS GUIDELINES

ADVANCED IMAGING

Appropriate Use Criteria: Imaging of the Extremities

Key to Revisions	Indicates
Blue	Insertion
~~Red~~	Deletion

Proprietary

AIM SpecialtyHealth
8600 West Bryn Mawr Avenue
South Tower – Suite 800 Chicago, IL 60631
www.aimspecialtyhealth.com

Appropriate.Safe.Affordable

Table of Contents

Description and Application of the Guidelines

The AIM Clinical Appropriateness Guidelines (hereinafter “the AIM Clinical Appropriateness Guidelines” or the “Guidelines”) are designed to assist providers in making the most appropriate treatment decision for a specific clinical condition for an individual. As used by AIM, the Guidelines establish objective and evidence-based criteria for medical necessity determinations where possible. In the process, multiple functions are accomplished:

- To establish criteria for when services are medically necessary
- To assist the practitioner as an educational tool
- To encourage standardization of medical practice patterns
- To curtail the performance of inappropriate and/or duplicate services
- To advocate for patient safety concerns
- To enhance the quality of health care
- To promote the most efficient and cost-effective use of services

The AIM guideline development process complies with applicable accreditation standards, including the requirement that the Guidelines be developed with involvement from appropriate providers with current clinical expertise relevant to the Guidelines under review and be based on the most up-to-date clinical principles and best practices. Relevant citations are included in the References section attached to each Guideline. AIM reviews all of its Guidelines at least annually.

AIM makes its Guidelines publicly available on its website twenty-four hours a day, seven days a week. Copies of the AIM Clinical Appropriateness Guidelines are also available upon oral or written request. Although the Guidelines are publicly-available, AIM considers the Guidelines to be important, proprietary information of AIM, which cannot be sold, assigned, leased, licensed, reproduced or distributed without the written consent of AIM.

AIM applies objective and evidence-based criteria, and takes individual circumstances and the local delivery system into account when determining the medical appropriateness of health care services. The AIM Guidelines are just guidelines for the provision of specialty health services. These criteria are designed to guide both providers and reviewers to the most appropriate services based on a patient’s unique circumstances. In all cases, clinical judgment consistent with the standards of good medical practice should be used when applying the Guidelines. Guideline determinations are made based on the information provided at the time of the request. It is expected that medical necessity decisions may change as new information is provided or based on unique aspects of the patient’s condition. The treating clinician has final authority and responsibility for treatment decisions regarding the care of the patient and for justifying and demonstrating the existence of medical necessity for the requested service. The Guidelines are not a substitute for the experience and judgment of a physician or other health care professionals. Any clinician seeking to apply or consult the Guidelines is expected to use independent medical judgment in the context of individual clinical circumstances to determine any patient’s care or treatment.

The Guidelines do not address coverage, benefit or other plan specific issues. Applicable federal and state coverage mandates take precedence over these clinical guidelines. If requested by a health plan, AIM will review requests based on health plan medical policy/guidelines in lieu of the AIM Guidelines.

The Guidelines may also be used by the health plan or by AIM for purposes of provider education, or to review the medical necessity of services by any provider who has been notified of the need for medical necessity review, due to billing practices or claims that are not consistent with other providers in terms of frequency or some other manner.

General Clinical Guideline

Clinical Appropriateness Framework

Critical to any finding of clinical appropriateness under the guidelines for a specific diagnostic or therapeutic intervention are the following elements:

- Prior to any intervention, it is essential that the clinician confirm the diagnosis or establish its pretest likelihood based on a complete evaluation of the patient. This includes a history and physical examination and, where applicable, a review of relevant laboratory studies, diagnostic testing, and response to prior therapeutic intervention.
- The anticipated benefit of the recommended intervention should outweigh any potential harms that may result (net benefit).
- Current literature and/or standards of medical practice should support that the recommended intervention offers the greatest net benefit among competing alternatives.
- Based on the clinical evaluation, current literature, and standards of medical practice, there exists a reasonable likelihood that the intervention will change management and/or lead to an improved outcome for the patient.

If these elements are not established with respect to a given request, the determination of appropriateness will most likely require a peer-to-peer conversation to understand the individual and unique facts that would supersede the requirements set forth above. During the peer-to-peer conversation, factors such as patient acuity and setting of service may also be taken into account.

Simultaneous Ordering of Multiple Diagnostic or Therapeutic Interventions

Requests for multiple diagnostic or therapeutic interventions at the same time will often require a peer-to-peer conversation to understand the individual circumstances that support the medical necessity of performing all interventions simultaneously. This is based on the fact that appropriateness of additional intervention is often dependent on the outcome of the initial intervention.

Additionally, either of the following may apply:

- Current literature and/or standards of medical practice support that one of the requested diagnostic or therapeutic interventions is more appropriate in the clinical situation presented; or
- One of the diagnostic or therapeutic interventions requested is more likely to improve patient outcomes based on current literature and/or standards of medical practice.

Repeat Diagnostic Intervention

In general, repeated testing of the same anatomic location for the same indication should be limited to evaluation following an intervention, or when there is a change in clinical status such that additional testing is required to determine next steps in management. At times, it may be necessary to repeat a test using different techniques or protocols to clarify a finding or result of the original study.

Repeated testing for the same indication using the same or similar technology may be subject to additional review or require peer-to-peer conversation in the following scenarios:

- Repeated diagnostic testing at the same facility due to technical issues
- Repeated diagnostic testing requested at a different facility due to provider preference or quality concerns
- Repeated diagnostic testing of the same anatomic area based on persistent symptoms with no clinical change, treatment, or intervention since the previous study
- Repeated diagnostic testing of the same anatomic area by different providers for the same member over a short period of time

Repeat Therapeutic Intervention

In general, repeated therapeutic intervention in the same anatomic area is considered appropriate when the prior intervention proved effective or beneficial and the expected duration of relief has lapsed. A repeat intervention requested prior to the expected duration of relief is not appropriate unless it can be confirmed that the prior intervention was never administered.

Imaging of the Extremities

General Information/Overview

Scope

These guidelines address advanced imaging of the extremities in both adult and pediatric populations. For interpretation of the Guidelines, and where not otherwise noted, “adult” refers to persons age 19 and older, and “pediatric” refers to persons age 18 and younger. Where separate indications exist, they are specified as **Adult** or **Pediatric**. Where not specified, indications and prerequisite information apply to persons of all ages.

See the Coding section for a list of modalities included in these guidelines.

Technology Considerations

Advanced imaging is an umbrella term that refers to anatomy-based (structural), physiology-based (functional), and hybrid imaging methods that offer greater spatial and/or contrast resolution relative to conventional imaging methods in radiology such as radiography or ultrasound. Examples of advanced structural imaging include computed tomography (CT) and magnetic resonance imaging (MRI) and some technique variants. Advanced functional imaging includes positron emission tomography (PET) as well as those MRI/CT technique variants that create image contrast based on a physiological parameter (for example, functional magnetic resonance imaging (fMRI). Hybrid advanced imaging techniques optimize diagnostic accuracy by coupling structural and functional approaches (such as PET-CT or PET-MRI).

In general, conventional radiographs should be obtained prior to advanced imaging. **Computed tomography (CT)** is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with **magnetic resonance imaging (MRI).** Tendons and ligamentous structures are better imaged using MRI. Use of contrast is at the discretion of both the ordering and imaging physicians. Implanted surgical hardware, including joint prostheses, may produce sufficient local artifact to preclude adequate imaging through the region containing hardware.

Disadvantages of CT include exposure to ionizing radiation and risks associated with infusion of iodinated contrast media, including allergic reactions or renal compromise. The presence of implantable devices such as pacemakers or defibrillators, a potential need for sedation in pediatric patients, and claustrophobia are the main limitations of MRI. Infusion of gadolinium may also confer an unacceptable risk in persons with advanced renal disease.

CT arthrography and **MR arthrography** are diagnostic tests performed by injecting contrast into the joint space prior to imaging. Injection is generally performed under fluoroscopic or ultrasound guidance. They are often preferable to standard CT or MRI for indications where visualization of the joint space integrity is needed.

Definitions

Phases of the care continuum are broadly defined as follows:

- **Screening** is testing in the absence of signs or symptoms of disease
- **Diagnosis** is testing based on a reasonable suspicion of a particular condition or disorder, usually due to the presence of signs or symptoms
- **Management** is testing to direct therapy of an established condition, which may include preoperative or postoperative imaging, or imaging performed to evaluate the response to nonsurgical intervention. Patients will usually have new or worsening signs or symptoms although progressive imaging findings may be sufficient in some scenarios.
- **Surveillance** is periodic assessment following completion of therapy, or for monitoring known disease that is stable or asymptomatic

Indeterminate lesion is a focal mass or mass-like finding identified on prior imaging that has not been confidently diagnosed as either benign or malignant based on imaging appearance and/or biopsy

Cannot be performed or is nondiagnostic applies when the test:

- Is positive or indeterminate for clinically significant pathology when the information provided about the abnormality by the test is not sufficient to direct subsequent management
- Is negative when the negative likelihood ratio of the test is both insufficient to confidently exclude the absence of suspected disease and unable to direct subsequent management. This typically applies in scenarios with moderate to high clinical pretest probability with negative testing or low pretest probability with clear evidence for net benefit
- Has been previously nondiagnostic because of a persistent clinical factor (e.g., body habitus, immobility) that is very likely to make retesting nondiagnostic as well
- Cannot be performed due to a medical contraindication (e.g., contrast nephrotoxicity, allergy, or in highly radiation sensitive populations such as pediatrics and pregnancy) or reasonable unavailability related to lack of local expertise or service availability.

General prerequisites for extremity imaging:

- **Conservative management**[1] – a combination of strategies to reduce inflammation, alleviate pain, and correct underlying dysfunction, including physical therapy **AND** at least **ONE** complementary conservative treatment strategy.
    - **Physical therapy requirement** includes **ANY** of the following:
        - Physical therapy rendered by a qualified provider of physical therapy services
        - Supervised home treatment program that includes **ALL** of the following:
            - Participation in a patient-specific or tailored program
            - Initial active instruction by MD/DO/PT with redemonstration of patient ability to perform exercises
            - Compliance (documented or by clinician attestation on follow-up evaluation)
        - Exception to the physical therapy requirement in unusual circumstances (for instance, intractable pain so severe that physical therapy is not possible) when clearly documented in the medical record
    - **Complementary conservative treatment requirement** includes **ANY** of the following:
        - Prescription strength anti-inflammatory medications and analgesics[2]
        - Adjunctive medications such as nerve membrane stabilizers or muscle relaxants[2]
        - Intra-articular corticosteroid injection(s)[2]
        - Alternative therapies such as acupuncture, chiropractic manipulation, massage therapy, activity modification, and/or a trial period of rest (e.g. from the aggravating/contributing factors) where applicable
    - **Exception to specified duration of conservative management** may be made in unusual circumstances (for example, worsening of symptoms during a course of conservative management) when clearly documented in the medical record, or when the duration period is substantiated by documentation of serial evaluation

[1] Additional condition or procedure specific requirements may apply and can be found in the respective sections of the guideline.

[2] In the absence of contraindications

- **Clinical reevaluation** – In most cases, reevaluation should include a physical examination. Direct contact by other methods, such as telephone communication or electronic messaging, may substitute for in-person evaluation when circumstances preclude an office visit.
- **Failure of conservative management** requires **ALL** of the following:

  - Patient has completed a full course of conservative management (as defined above) for the current episode of care
  - Worsening of or no significant improvement in signs and/or symptoms upon clinical reevaluation
  - More invasive forms of therapy are being considered

Statistical terminology

- **Confidence interval (CI) –** range of values which is likely to contain the cited statistic. For example, 92% sensitivity (95% CI, 89%-95%) means that, while the sensitivity was calculated at 92% on the current study, there is a 95% chance that, if a study were to be repeated, the sensitivity on the repeat study would be in the range of 89%-95%.
- **Diagnostic accuracy –** ability of a test to discriminate between the target condition and health. Diagnostic accuracy is quantified using sensitivity and specificity, predictive values, and likelihood ratios.
- **Hazard ratio –** odds that an individual in the group with the higher hazard reaches the outcome first. Hazard ratio is analogous to odds ratio and is reported most commonly in time-to-event analysis or survival analysis. A hazard ratio of 1 means that the hazard rates of the 2 groups are equivalent. A hazard ratio of greater than 1 or less than 1 means that there are differences in the hazard rates between the 2 groups.
- **Likelihood ratio –** ratio of an expected test result (positive or negative) in patients with the disease to an expected test result (positive or negative) in patients without the disease. Positive likelihood ratios, especially those greater than 10, help rule in a disease (i.e., they substantially raise the post-test probability of the disease, and hence make it very likely and the test very useful in identifying the disease). Negative likelihood ratios, especially those less than 0.1, help rule out a disease (i.e., they substantially decrease the post-test probability of disease, and hence make it very unlikely and the test very useful in excluding the disease).
- **Odds ratio –** odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. An odds ratio of 1 means that the exposure does not affect the odds of the outcome. An odds ratio greater than 1 means that the exposure is associated with higher odds of the outcome. An odds ratio less than 1 means that the exposure is associated with lower odds of the outcome.
- **Predictive value –** likelihood that a given test result correlates with the presence or absence of disease. Positive predictive value is defined as the number of true positives divided by the number of test positives. Negative predictive value is defined as the number of true negatives divided by the number of test negative patients. Predictive value is dependent on the prevalence of the condition.
- **Pretest probability –** probability that a given patient has a disease prior to testing. May be divided into very low (less than 5%), low (less than 20%), moderate (20%-75%), and high (greater than 75%) although these numbers may vary by condition.
- **Relative risk –** probability of an outcome when an exposure is present relative to the probability of the outcome occurring when the exposure is absent. Relative risk is analogous to odds ratio; however, relative risk is calculated by using percentages instead of odds. A relative risk of 1 means that there is no difference in risk between the 2 groups. A relative risk of greater than 1 means that the outcome is more likely to happen in the exposed group compared to the control group. A relative risk less than 1 means that the outcome is less likely to happen in the exposed group compared to the control group.
- **Sensitivity –** conditional probability that the test is positive, given that the patient has the disease. Defined as the true positive rate (number of true positives divided by the number of patients with disease). Excellent or high sensitivity is usually greater than 90%.
- **Specificity –** conditional probability that the test is negative, given that the patient does not have the disease. Defined as the true negative rate (number of true negatives divided by the number of patients without the disease). Excellent or high specificity is usually greater than 90%.

Clinical Indications

The following section includes indications for which advanced imaging of the extremities is considered medically necessary, along with prerequisite information and supporting evidence where available. Indications, diagnoses, or imaging modalities not specifically addressed are considered not medically necessary.

It is recognized that imaging often detects abnormalities unrelated to the condition being evaluated. Such findings must be considered within the context of the clinical situation when determining whether additional imaging is required.

General prerequisites for extremity imaging include conservative management and clinical reevaluation, as defined above. Documentation of compliance with a plan of therapy that includes elements of conservative management may be required. Exceptions may be considered on a case-by-case basis.

Congenital and Developmental Conditions

Congenital or developmental anomalies of the extremity (Pediatric only)

Advanced imaging is considered medically necessary for diagnosis and management when radiographs are nondiagnostic or not sufficient to guide treatment.

IMAGING STUDY

- For acetabular dysplasia or developmental dysplasia of the hip (DDH), initial evaluation with hip ultrasound is required in infants with a corrected age of 4 months or less
- CT upper extremity; CT lower extremity
- MRI upper extremity (joint or non-joint); MRI lower extremity

Tarsal coalition

Advanced imaging is considered medically necessary for diagnosis and management when radiographs are nondiagnostic or not sufficient to guide treatment.

IMAGING STUDY

- CT lower extremity
- MRI lower extremity

Rationale

Tarsal coalition refers to fusion—osseous, cartilaginous or fibrinous—of the tarsal bones, typically talocalcaneal or calcaneonavicular (90%)[1] and is an important cause of foot pain, especially in adolescents; it is responsible for foot pain in up to 13% of cases.[1] Radiographs are commonly the initial diagnostic imaging study[2, 3] and have reasonable sensitivity (~80%) and high specificity (~97%)[1, 2] for establishing the diagnosis of bony disease. Radiographs are also useful to exclude other causes of foot pain which can mimic the presentation of tarsal coalition, especially acutely. When radiographs are nondiagnostic or not sufficient to guide treatment, CT or MRI can be used to further delineate the extent of disease and to identify occult disease or associated abnormalities.[1]

Infection

Soft tissue infection

Advanced imaging is considered medically necessary for diagnosis and management when radiographs or ultrasound are nondiagnostic or not sufficient to guide treatment in **ANY** of the following scenarios:

- Localization of known or suspected abscess, to direct surgical treatment
- Known or suspected fasciitis

- Other soft tissue infection not responsive to treatment

IMAGING STUDY

- MRI upper extremity (joint or non-joint); MRI lower extremity
- CT upper or lower extremity as an alternative to MRI for known or suspected abscess
- CT upper or lower extremity when MRI cannot be performed for indications other than abscess

Osteomyelitis or septic arthritis

Advanced imaging is considered medically necessary for diagnosis and management when radiograph, ultrasound, or arthrocentesis is nondiagnostic or not sufficient to guide treatment.

IMAGING STUDY

- MRI upper extremity (joint or non-joint); MRI lower extremity (preferred)
- CT upper or lower extremity when MRI cannot be performed
- FDG-PET for chronic osteomyelitis

Rationale

OSTEOMYELITIS

Though radiographs often do not show abnormalities associated with osteomyelitis in the first two weeks of the infection, they can detect other pathologies that may contribute to the patient's symptoms. The information provided by radiographs generally complements that provided by other modalities, so radiographs should be performed even when other imaging is planned.

Radiographs are the appropriate initial imaging study in osteomyelitis because they can demonstrate findings suggestive of the diagnosis, but can also exclude or provide information to suggest other diagnoses. The sensitivity of radiography is reportedly 43%-75% and the specificity is 75%-83%. Abnormal radiographs are helpful, but the diagnosis cannot be excluded on the basis of negative radiographs. The sensitivity and specificity of CT are not well established, but the sensitivity is known to be lower than that of MRI. For this reason, the utility of CT is limited to specific situations. For example, CT can be used to detect bony sequestra, and has an important role in determining operative therapy.[4]

Overall, CT has a limited role in the diagnosis of osteomyelitis, and should be used only when imaging is being done to assess the extent of bone destruction, to direct a biopsy, or when MRI is contraindicated. For early detection of osteomyelitis, MRI is superior to other imaging modalities. The sensitivity and specificity for MRI are 78%-90% and 60%-90%, respectively. This compares to sensitivity and specificity of 67% and 50% for CT, and 14%-54% and 68%-70% for radiography.[5]

The American College of Radiology Appropriateness Criteria rate radiographs as "usually appropriate" for initial evaluation of suspected osteomyelitis. CT, MRI, and ultrasound are all rated as "usually not appropriate" regardless of whether the studies are performed with IV contrast. For evaluation of suspected osteomyelitis following radiographs, MRI without and with IV contrast is preferred, with a comment that radiographs and MRI are both indicated and complementary. MRI without contrast is generally appropriate if contrast is contraindicated, and CT with IV contrast is generally appropriate if MRI is contraindicated. [6]

SEPTIC ARTHRITIS

The diagnosis of septic arthritis is established by joint aspiration and culture of the synovial fluid. Initial evaluation for septic joint should include radiography (to outline anatomic detail, evaluate for radiodense foreign bodies or soft-tissue gas, and exclude alternate diagnoses such as fracture, degenerative changes, or tumor). [6,7] Additional imaging with CT or MRI may be utilized for further evaluation in children, high-risk adults, and for preoperative planning for confirmed septic arthritis. In children, MRI may also be useful to evaluate for associated osteomyelitis or cartilage involvement. The American College of Radiology recommends MRI to further clarify and stage conditions diagnosed clinically and/or suggested by other imaging modalities, including, but not limited to, the following: inflammatory, infectious, neuropathic, degenerative, crystal-induced, or post-traumatic arthritis.[8] Compared to other advanced imaging modalities, MRI is generally preferred for septic arthritis for its ability to assess soft tissue infection, osteomyelitis, and abscess. [6,7] MRI is highly sensitive for the diagnosis of septic arthritis, although it still lacks specificity as it cannot reliably distinguish inflamed from infected joints.[9] CT may be utilized when MRI is contraindicated.

Inflammatory Conditions

Capitellar osteochondritis

Advanced imaging is considered medically necessary following nondiagnostic radiographs when the results of imaging are essential to establish a diagnosis or direct management.

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity when MRI cannot be performed

Juvenile idiopathic arthritis (Pediatric only)

Also see Spine Imaging guidelines

Advanced imaging of the extremity is considered medically necessary for management of established juvenile idiopathic arthritis when radiographs are insufficient to determine appropriate course of therapy, particularly intra-articular therapy.

IMAGING STUDY

- MRI upper extremity (joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

Juvenile idiopathic arthritis (JIA), the most common rheumatic disease of children and adolescents, is an umbrella term that encompasses all forms of arthritis that begin before age 16, persist for more than 6 weeks, and are of unknown etiology. Examples of JIA include oligoarthritis, polyarthritis, systemic arthritis, psoriatic arthritis, and enthesis-related arthritis. JIA is the most common childhood rheumatic entity with a prevalence of 0.6 to 1.9 in 1000 children.[10]

JIA is primarily a clinical diagnosis. General practitioners should base diagnosis of JIA (and differential diagnosis) primarily on history and clinical examination, with strong suspicion of JIA indicated by pain and swelling of single or multiple joints, persistent or worsening loss of function, fever of at least 10 days with unknown cause (often associated with transient erythematous rash), decreased range of motion, and joint warmth or effusion.[11]

Laboratory assessment with appropriate tests can assist in increasing diagnostic certainty, excluding differential diagnoses, and predicting patients likely to progress to erosive disease. Base investigations usually include erythrocyte sedimentation rate or C-reactive protein and full blood count, with consideration given to rheumatoid factor, antinuclear antibody, and human leukocyte antigen B27.[11]

When there is clinical diagnostic doubt, conventional radiographs (CR), ultrasound, or MRI can be used to improve the certainty of a diagnosis of JIA above clinical features alone.[12] MRI is the most sensitive noninvasive imaging modality to evaluate for inflammation of the joints, tendons, and entheses, and is the only modality that can depict bone marrow edema. Currently, MRI with contrast is the most sensitive tool for determining active synovitis.[10]

When the imaging modalities were directly compared, MRI and ultrasound detected more joint damage than CR, but primarily at the hip (MRI vs CR detection rate, mean [range] 1.54-fold [1.08–2.0-fold]; ultrasound vs CR detection rate, mean 2.29-fold), and at the wrist (MRI vs CR detection rate, 1.36-fold [1.0–2.0-fold]).[12]

Imaging studies help identify children with a high likelihood of early erosive joint damage, providing an opportunity to implement aggressive therapy at an early stage in an attempt to reduce morbidity.[10]

Myositis

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Localization for biopsy
- Monitor response to therapy

IMAGING STUDY

- MRI upper extremity (non-joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed

Note: Bilateral imaging may be appropriate to assess optimal site for biopsy when symptoms are generalized (not localized to one site).

Plantar fasciitis and fibromatosis

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Evaluation for plantar fasciitis following a failure of at least 6 months of treatment, including at least two of the following: mechanical de-weighting, foot orthosis, night splints, taping, or manual therapy
- Diagnosis and management of plantar fibromatosis when ultrasound cannot be performed or is nondiagnostic and following a failure of at least 3 months of conservative management including corticosteroid injections

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed

Trauma

Acute traumatic injuries –not otherwise specified [MJ1]

This indication applies to traumatic injuries not addressed elsewhere in the Extremity Imaging guidelines. See pain indications or ligament/tendon derangements for subacute or chronic injuries.

Advanced imaging is considered medically necessary when radiographs are nondiagnostic or not sufficient to establish a diagnosis and direct management.

IMAGING STUDY

- CT upper extremity; CT lower extremity
- MRI upper extremity (joint or non-joint); MRI lower extremity

Rationale

For evaluation of musculoskeletal trauma, radiologists judge radiographs to be "essential" or "very important" for use in the interpretation of MRI. When advanced imaging is warranted, having radiographs available at the time of advanced imaging allows the radiologist to more appropriately protocol the study, as well as to determine which study will best assess the clinical and radiographic concerns.[13]

Fracture[MJ2]

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Detection of occult fracture following nondiagnostic radiographs at high-risk/weight bearing sites:
  - Upper extremity:
    - Scaphoid
    - Lunate
  - Lower extremity:
    - Femoral neck, proximal femur
    - Tibia (anterior/lateral/plateau)
    - Patella
    - Talus
    - Navicular
    - Metatarsal base (second and fifth digits)
    - Great toe sesamoid
    - Calcaneus (in individuals when imaging will direct the timing of return to vigorous athletic activity)

- Evaluation of supracondylar, intra-articular, or Salter-Harris (growth plate) fractures when radiographs are insufficient for management
- To assess fracture healing for delayed union or nonunion when radiographs are nondiagnostic

IMAGING STUDY

- MRI upper extremity (joint or non-joint); MRI lower extremity
- CT upper or lower extremity for preoperative planning
- CT upper or lower extremity for detection of occult fracture when MRI cannot be performed
- CT upper extremity (joint or non-joint) for delayed union or nonunion of the scaphoid as an alternative to MRI
- CT lower extremity as an alternative to MRI for evaluation of tibial plateau fracture

Rationale

Though MRI is often more sensitive than radiography in detecting occult fractures, radiography remains the initial study of choice for clinically suspected fractures with good specificity (greater than 88%) but limited sensitivity (less than 56%).[14,13] CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with MRI.

While many types of stress fractures are diagnosed clinically and managed conservatively,[15] high-risk fracture sites are susceptible to nonunion.[16, 17] Early diagnosis is important, as these fractures may require prolonged immobilization or surgical intervention.[16] Advanced imaging, preferably MRI, is indicated when radiographs are nondiagnostic to support this management change.

SUSPECTED SCAPHOID FRACTURE

For initial evaluation of suspected scaphoid fracture, radiographs (via the finding of a fat pad sign) have a sensitivity of 82% (95% CI, 77%-86%) and specificity of 72% (95% CI, 68%-75%). The pretest probability of scaphoid fracture when radiographs do not demonstrate a fracture but the history and physical examination are consistent with the diagnosis is 25%. Regarding follow-up imaging after negative radiographs, CT has a sensitivity of 83% (95% CI, 75%-89%) and specificity of 97% (95% CI, 94%-99%). The diagnostic accuracy of MRI is superior to CT, with 96% sensitivity (95% CI, 92%-99%) and 98% specificity (95% CI, 96%-99%).[18]

SUSPECTED HIP FRACTURE WITH NEGATIVE OR INCONCLUSIVE RADIOGRAPHS

Stress or fragility fractures, especially those of the subcapital hip, may progress to complete fractures. Subcapital hip fractures are often complicated by avascular necrosis unless surgically treated; as such, accurate detection is important. Clinically, these fractures most commonly present with hip pain after trauma, and the patient may be unable to bear weight. When radiographs are negative or indeterminate, MRI is sensitive and specific for diagnosis and is better able to diagnose soft tissue causes of hip pain that may mimic fracture; these may include musculotendinitis and bursal abnormalities.[19]

There is consensus among multiple high-quality evidence-based guidelines that advanced imaging (most commonly MRI) is indicated in patients with suspected stress of fragility fracture when initial and or follow-up radiography is negative. MRI has a high diagnostic yield in this patient population—especially for elderly patients—and establishing the diagnosis frequently changes management.

CHOICE OF IMAGING STUDY

Moderate evidence supports MRI as the advanced imaging modality of choice for diagnosis of presumed hip fracture not apparent on initial radiographs.[19] For suspected hip fracture, MR imaging is the imaging study of choice when there is doubt regarding the diagnosis. If MR is not available or not feasible, a radioisotope bone scan or repeat plain radiographs (after a delay of 24-48 hours) should be performed.[20]

A 2016 systematic review of imaging modalities in lower extremity stress fractures found greater sensitivity for MRI (68%-99%) than CT (32%-38%) and comparable but wide-ranging specificities (4%-97% for MRI, 88%-98% for CT). In assessing the data, the authors conclude that "MRI was identified as the most sensitive and specific imaging test for diagnosing stress fractures of the lower extremity."[14] Highlighting the superior sensitivity of MRI, a recent retrospective study of 44 patients found that MRI changed management in up to 61% of cases following inconclusive radiographs and CT.[21]

~~Traumatic injuries – acute/not otherwise specified~~

~~*This indication applies to traumatic injuries not addressed elsewhere in the Extremity Imaging guidelines. See pain indications or ligament/tendon derangements for subacute or chronic injuries.*~~

~~Advanced imaging is considered medically necessary when radiographs are nondiagnostic or not sufficient to establish a diagnosis and direct management.~~

~~IMAGING STUDY~~

- ~~CT upper extremity; CT lower extremity~~
- ~~MRI upper extremity (joint or non-joint); MRI lower extremity~~

~~**Rationale**~~

~~For evaluation of musculoskeletal trauma, radiologists judge radiographs to be "essential" or "very important" for use in the interpretation of MRI. When advanced imaging is warranted, having radiographs available at the time of advanced imaging allows the radiologist to more appropriately protocol the study, as well as to determine which study will best assess the clinical and radiographic concerns.~~[13]

Tumor/Neoplasm

See Oncologic Imaging guidelines for management of an established malignancy.

Brachial plexus mass

Advanced imaging is considered medically necessary to further characterize a brachial plexus mass identified on clinical exam or prior imaging or when suspected by electromyography.

IMAGING STUDY

- MRI upper extremity (non-joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Indeterminate bone lesion

Advanced imaging is considered medically necessary for diagnosis and management following nondiagnostic radiographs.

IMAGING STUDY

- MRI upper extremity (joint or non-joint); MRI lower extremity (preferred)
- CT upper extremity; CT lower extremity

Morton's neuroma

Advanced imaging is considered medically necessary for presurgical planning when ultrasound cannot be performed or is nondiagnostic, and failure of at least 6 weeks of conservative management, including a focused steroid injection and use of foot orthoses.

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Pigmented villonodular synovitis

Advanced imaging is considered medically necessary when the results of imaging are essential to establish a diagnosis or direct management.

IMAGING STUDY

- MRI upper extremity (joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

Pigmented villonodular synovitis exists in both diffuse and localized forms. Radiographic findings are nonspecific, and radiographs may be normal in up to approximately 20% of cases. In localized disease, a soft tissue mass may be evident. In diffuse disease, there may be a joint effusion as well as erosive changes. Radiographic changes including osteopenia, joint space narrowing, and degenerative changes may less commonly be present. CT arthrography and MR arthrography reveal synovial thickening with nodular projections into the joint.[22]

The extent of disease is better demonstrated with MR arthrography than with CT arthrography. However, CT is ideal for demonstrating bony erosion and subchondral cystic change. The CT appearance of pigmented villonodular synovitis is less well described than its appearance on MR arthrography. Because the clinical and radiographic findings, particularly in diffuse disease, are nonspecific, MR is typically the study chosen as a follow up to radiography.[22]

Soft tissue mass – not otherwise specified

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Evaluation of a superficial or palpable non-popliteal mass following nondiagnostic radiograph or ultrasound
- Evaluation of a superficial or palpable popliteal (posterior knee) mass following nondiagnostic radiographs and ultrasound
- Soft tissue evaluation when prominent calcifications are seen on radiograph
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance of a soft tissue mass identified on prior imaging without pathologic tissue confirmation

IMAGING STUDY

- MRI upper extremity (joint or non-joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

Initial evaluation of a palpable or superficial soft tissue mass should include an ultrasound or plain radiographs. Plain radiography provides useful information about the relationship between the mass and the joint, any regional bone or joint abnormalities, and may define characteristic patterns of ossification or calcification within the mass or demonstrate internal fat. Ultrasound also provides useful information and can fully characterize superficial lesions such as lipomas, sebaceous or Baker's cysts.

The initial evaluation for suspected popliteal (Baker's) cyst should include an ultrasound and plain radiographs. Plain radiography provides limited information about the popliteal cyst, but may provide additional information on joint and bone abnormalities such as loose bodies in the cyst or the general findings of osteoarthritis and inflammatory arthritis. Ultrasound, however, is preferred and considered invaluable for evaluation of a Baker's cyst as it is readily available, noninvasive, involves no exposure to radiation, and allows assessment of the cyst including size, extent, and relation to surrounding tissue. In the clinical scenario where plain radiograph and ultrasound are nondiagnostic for a Baker's cyst, an MRI may be useful. As ultrasound is not sensitive for intra-articular lesions, an MRI can confirm the cystic, unilocular nature of a benign popliteal cyst, evaluate its relationship to anatomic structures in the joint and surrounding tissue, and delineate associated intra-articular pathologies.[23]

Among patients presenting for primary care evaluation of a soft tissue mass, a benign cause is found in 95% of cases.[24] Radiographic findings are often nonspecific. However, there are some radiographic findings that are characteristic of certain masses. Examples include phleboliths, which are suggestive of hemangiomas, as well as trabecular bone adjacent to a soft tissue mass, which—when combined with a history of trauma—suggests myositis ossificans. The radiographic findings may help direct next steps in evaluation of the mass, such as a clinical situation where the most appropriate next study is CT. For most soft tissue masses, MRI is the more appropriate follow-up study.[25]

Ligament and Tendon Derangement of the Upper Extremity

Note: MRI is preferable to CT for evaluation of internal derangements of tendinous, ligamentous, and cartilaginous structures. Except where noted, CT should be limited to situations where there is a contraindication to MRI.

Adhesive capsulitis (Adult only)

Advanced imaging is considered medically necessary when **BOTH** of the following criteria are met:

- Nondiagnostic radiographs
- Manipulation under anesthesia or arthroscopic lysis of adhesions is planned

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity

Rationale

There is no agreement on the imaging features of adhesive capsulitis. A single high-quality evidence-based guideline suggests that imaging is not initially indicated but that MRI may be considered prior to manipulation.[26]

Labral tear – shoulder

Advanced imaging is considered medically necessary for diagnosis and management in **ANY** of the following scenarios:

- Recurrent anterior shoulder dislocation or subluxation
- First-time dislocation in a young patient at high risk for recurrence
- Acute traumatic event with evidence of suprascapular nerve entrapment
- Following acute trauma, with radiographic suspicion of a bony Bankart lesion (anteroinferior glenoid fracture)
- Symptoms* AND physical exam findings** of SLAP tear, and failure of at least 6 weeks of conservative management

**Symptoms are pain aggravated by heavy lifting, pushing, or overhead motion.*

***Physical exam demonstrating a positive response to **ANY** of following tests:*

- *O'Brien (active compression) test*
- *Anterior slide test*
- *Biceps load test (I and II)*
- *Pain provocation test*
- *Crank test*
- *Jobe relocation test*
- *Forced shoulder abduction and elbow flexion test*
- *Resisted supination external rotation test*

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Rationale

In general, MR arthrogram is more accurate than MRI in diagnosing and excluding labral tears. CT and MR arthrogram have comparable diagnostic accuracy in evaluation of superior labral anterior to posterior (SLAP) tears, Bankart lesions, and humeral head/Hill-Sachs fractures. CT arthrogram may have slightly better diagnostic accuracy for glenoid rim fractures and anterior labral periosteal sleeve avulsion fractures. In the absence of intra-articular contrast, CT should only be performed for this indication when there is a contraindication to MRI.

In a meta-analysis comparing MR arthrogram (N = 2013) to MRI (N=1498) in patients with suspected SLAP tears, MR arthrogram was superior to MRI in the detection of SLAP lesions. MR arthrogram had higher sensitivity (87% vs 76%), specificity (92% vs 87%), positive likelihood ratio (10.28 vs 5.89), and negative likelihood ratio (0.14 vs 0.28) than MRI.[27]

A 2012 meta-analysis by Smith et al. reviewed 4574 patients and 4667 shoulders in patients presenting with suspected labral tear and clinical signs and/or symptoms of shoulder instability. MRI had a sensitivity of 76% (95% CI, 72%-80%) and specificity of

87% (95% CI, 84%-90%), while MR arthrogram had a sensitivity of 88% (95% CI, 86%-90%) and specificity of 93% (95% CI, 92%-95%) in the evaluation of all labral tears. For evaluation of anterior labral tears, MRI (sensitivity 92% [95% CI, 88%-96%], specificity 98% [95% CI, 98%-99%]) was more accurate than MR arthrogram (sensitivity 84%, [95% CI, 79%-89%], specificity 93% [95% CI, 90%-95%]). No significant difference was found between MRI and MR arthrogram in the detection of posterior or superior labral tears. For SLAP tears, MR arthrogram showed slightly higher diagnostic accuracy (sensitivity 83% [95% CI, 79%-87%], specificity 93% [95% CI, 90%-96%]) than MRI (sensitivity 79% [95% CI, 75%-93%], specificity 87% [95% CI, 83%-91%]).[28]

Though MR arthrogram is considered the reference standard for shoulder imaging, CT arthrography could also provide a valuable preoperative assessment, given its excellent spatial resolution, multiplanar capacity, and high-contrast resolution.[29]

In nontraumatic cases, there is agreement that imaging is not initially indicated prior to 4 weeks of conservative care. Clinical tests such as O'Brien, Neer, and Yergason tests are used to diagnose labral lesions. Since most SLAP tears are associated with other pathology, the provider should identify other shoulder conditions, if any, and follow appropriate surgical indications. Indications for surgical treatment of SLAP tears are not standardized and remain somewhat controversial. Expert opinion, including the American Academy of Orthopedic Surgeons, recommends initial conservative care for SLAP tears. In general, conservative management should last a minimum of 6 to 12 weeks. Early surgery should be considered only when there is evidence of symptomatic suprascapular nerve compression.[30]

Besides the typical history of repetitive dislocation episodes, the diagnosis of chronic anterior instability of the shoulder is usually confirmed by imaging. Conventional radiographs and CT scans can provide useful information about bone status, but so far, MR arthrography represents the gold standard for prearthroscopy evaluation.[31]

Ligament and tendon injuries – upper extremity, not listed elsewhere

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Diagnosis supported by history and physical exam, and there has been no substantial improvement on clinical reevaluation following a trial of conservative management
- Radiograph suggestive of scapholunate ligament tear

IMAGING STUDY

- MRI upper extremity (joint)

Rotator cuff tear

Advanced imaging is considered medically necessary for diagnosis and management when **ALL** of the following apply:

- Radiographs or ultrasound are nondiagnostic
- At least one positive sign to support the diagnosis of rotator cuff tear has been demonstrated
- **EITHER** of the following:
  - At least one positive sign of a complete rotator cuff tear
  - Failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Rationale

Rotator cuff tears usually occur as a result of trauma, and are rare in the young (age < 35 years) but common in older people, in whom the trauma may be minimal, and tears may be asymptomatic. Radiography is a useful initial screening modality for acute shoulder pain of all causes[32] and is recommended as the initial imaging modality by multiple high-quality evidence-based and practice based guidelines.[26,33]

There is consensus among multiple high-quality evidence-based guidelines that imaging is generally not indicated for suspected atraumatic rotator cuff tear unless the patient has failed a 4 to 6 week course of conservative care or has red flags/high risk features. Imaging is not indicated in patients with full or limited movement and nontraumatic shoulder pain of less than 4 weeks duration.[26] MRI or ultrasound may be considered when shoulder pain is refractory to 4 to 6 weeks of an appropriate shoulder rehabilitation program and the diagnosis has not been identified through clinical exam.[33] In the absence of red flag symptoms, X-rays and imaging are not indicated in the first 4 to 5 weeks for an injured worker presenting with suspected rotator cuff syndrome.[34]

High-risk features, for which early intervention confers a better prognosis, include infection, neoplasm, high-impact trauma, and specific clinical features suggestive of a full-thickness rotator cuff tear.[30,35]

According to Handoll et al., imaging is not indicated for shoulder pain in the primary care setting unless there is a suspicion of serious pathology. Imaging and surgical intervention should only be considered after conservative treatment has failed.[36]

CHOICE OF IMAGING STUDY

There is consensus among multiple high-quality evidence-based guidelines that MRI, MR arthrogram, and ultrasound are all accurate in the assessment of full thickness rotator cuff tears. All three modalities are more accurate in identifying full thickness tears than partial thickness tears. CT arthrography and MR arthrography have comparable diagnostic accuracy in the evaluation of full thickness rotator cuff tears. MR arthrogram is accurate in detecting rotator cuff lesions such as partial articular supraspinatus tendon avulsions and concealed interstitial delaminations.[26,33]

A 2013 meta-analysis by Lenza et al. extracted data from 20 prospective studies (1147 shoulders) in patients with shoulder pain being considered for surgery. The authors found no statistically significant difference between MRI, MR arthrogram, and ultrasound in the diagnostic accuracy for the detection of full thickness tears (P = .07), partial thickness tears (P = 1.0), or any tear (P = 0.13). For full thickness tears, MRI (7 studies, 368 shoulders) had a sensitivity of 94% (95% CI, 85%-98%). The positive and negative likelihood ratios were 13 (95% CI, 6-29) and 0.06 (95% CI, 0.02-0.23). The authors concluded that there was no evidence to suggest differences in the sensitivities and specificities of MRI and ultrasound for detecting any rotator cuff tears or partial thickness tears. The authors also found no evidence to suggest differences in the sensitivities and specificities of MRI, MR arthrogram, and ultrasound for detecting full thickness tears.[37]

A 2015 meta-analysis by Roy et al. found no statistically significant difference in the sensitivity or specificity of MRI, MR arthrogram, and ultrasound in the detection of rotator cuff tears. For ultrasound, based on 25 studies and 2774 shoulders, the sensitivity was 91% and specificity was 86%. For MRI, based on 21 studies and 1575 shoulders, sensitivity and specificity were both 90%. For MR arthrogram, based on 14 studies and 979 shoulders, the sensitivity and specificity were both 90%.[35]

Tendon rupture – biceps or triceps

Advanced imaging is considered medically necessary when the results of imaging are essential to establish a diagnosis or direct management.

IMAGING STUDY

- MRI upper extremity (joint)

Triangular fibrocartilage complex tear

Advanced imaging is considered medically necessary following nondiagnostic radiographs in **EITHER** of the following scenarios:

- Suspected acute tear
- Suspected chronic tear with failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Rationale

In comparing CT arthrography and MRI (without arthrography), dorsal segment tears were only detected with CT arthrography. For palmar tears, the sensitivity and specificity of CT arthrography were 100% and 77%, respectively, compared to 60% sensitivity and 77% specificity for MRI. For central segment tears, the sensitivity and specificity of CT arthrography were 86% and 50%, respectively, compared to 79% sensitivity and 25% specificity for MRI. In addition, inter-observer agreement was better for CT arthrography ($k = 0.37\text{-}0.78$) compared to MRI ($k = -0.33–0.10$).[38]

MRI is preferable to CT for evaluation of internal derangements of the joints and related tendinous, ligamentous, and cartilaginous structures. However, both MR arthrography and CT arthrography are appropriate. In the absence of arthrography, CT should only be used for this indication when there is a contraindication to MRI.

Ulnar collateral ligament tear (elbow or thumb)

Ulnar collateral ligament tear at the thumb is also known as gamekeeper's thumb.

Advanced imaging is considered medically necessary for diagnosis and management

IMAGING STUDY

- MRI upper extremity (joint)
- MRI upper extremity (non-joint)

Ligament and Tendon Derangement of the Lower Extremity

Note: MRI is preferable to CT for evaluation of internal derangements of tendinous, ligamentous, and cartilaginous structures. Except where noted, CT should be limited to situations where there is a contraindication to MRI.

Labral tear and femoral acetabular impingement – hip

Advanced imaging is considered medically necessary following nondiagnostic radiographs when **BOTH** of the following are present:

- Moderate to severe hip pain that interferes with activities of daily living or is worsened by flexion, **OR** positive impingement on clinical exam
- Failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

Consensus among high-quality evidence-based guidelines is that imaging may be indicated when radiographs are negative or equivocal. Recommendations about choice of imaging study are inconsistent.

- MR arthrography or CT arthrography is appropriate in patients with chronic hip pain when a labral tear is suspected and radiographs are negative, equivocal, or nondiagnostic.[39]
- MRI is useful in detecting musculotendinous pathology such as iliopsoas tendinopathy. Although MRI is not used widely to detect intra-articular injury, some investigators report high accuracy (89%-95%) in detecting labral tears. Currently, the most common imaging procedure used to confirm the diagnosis of intra-articular pathology, such as labral tears or chondral lesions, is MR arthrography.[40]
- A systematic review of 29 studies (13 MRI [10 @ 1.5T], 16 MR arthrography [13 @ 1.5T]) assessing the diagnostic accuracy of MRI or MR arthrography for labral tear in 872 patients found that both conventional MRI and MR arthrography provide acceptable ability in detecting acetabular labral tears in adults. The sensitivity of MR arthrography was greater than conventional MRI in detecting an acetabular labral tear when one was present, but conventional MRI had a higher specificity than MR arthrography in detecting a negative result when no labral tear was evident. The authors conclude that “both MRI and MR arthrography may be useful adjuncts in the diagnosis of acetabular labral tears in adults, but MR arthrography appears to be superior to conventional MRI based on the current evidence.”[41]

Ligament tear – knee

Advanced imaging is considered medically necessary in **ANY** of the following scenarios following nondiagnostic radiographs or ultrasound:

- Failure of at least 4 weeks of conservative management
- Preoperative evaluation when **ANY** of the following physical examination tests are positive:
  - Anterior or posterior drawer
  - Lachman
  - Medial or lateral stress suggestive of grade 3 sprain
  - Pivot shift test
- Postoperative evaluation following a ligament or tendon repair when there are new symptoms

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed

Ligament and tendon injury and rupture – foot and ankle

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Suspected ligament or tendon rupture
- Radiographs or ultrasound are nondiagnostic, and patient has completed a period of protected weight-bearing, immobilization or strapping, of at least 4 weeks duration

IMAGING STUDY

- MRI lower extremity

Lisfranc injury

Advanced imaging is considered medically necessary following nondiagnostic radiographs when the results of imaging are essential to establish a diagnosis or direct management.

IMAGING STUDY

- MRI lower extremity
- CT lower extremity

Meniscal tear/injury

Advanced imaging is considered medically necessary following nondiagnostic radiographs in **EITHER** of the following scenarios:

- Preoperative evaluation of acute knee pain after injury when **ANY** of the following are present:
  - Symptoms of locking, catching, or instability
  - At least **ONE** physical exam finding of meniscal tear:
    - Joint swelling or effusion
    - Positive McMurray or Apley test
    - Joint line tenderness
    - Inability to fully extend the knee
- Chronic knee pain in **EITHER** of the following scenarios:
  - Symptoms of locking, catching, or instability **AND** at least **TWO** of the following physical exam findings of meniscal tear:
    - Joint swelling or effusion
    - Positive McMurray or Apley test
    - Joint line tenderness
    - Inability to fully extend the knee
  - Pain with at least **ONE** physical exam finding of meniscal tear and failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed

Rationale

In patients with nontraumatic knee pain without initial radiographic evidence of underlying pathology, consensus among multiple high-quality evidence-based guidelines suggests that a period of conservative care is indicated in patients prior to advanced imaging.[42,43] In patients without gross instability or prior surgery, studies have shown no difference in patient-centered outcomes (short or long term pain, quality of life, functional limitations) for patients with knee pain and suspected internal derangement who receive MRI at the time of initial primary care consultation versus delayed MRI after conservative care and orthopedic referral.[44] In patients who have failed conservative treatment, or when history or physical findings are suggestive of injury whereby surgical treatment is planned, an MRI is the most appropriate imaging study.[45] Strong evidence suggests that MRI can provide confirmation of injury and assist in identifying concomitant knee pathology such as other ligament, meniscal, or articular cartilage injury.[46]

The use of CT for evaluation of internal knee pathology has been looked at prospectively in 2 separate trials. Heffernan et al. found that multidetector CT imaging had very high sensitivity and specificity for anterior cruciate ligament (ACL) tears (87.5%-100%, with a specificity of 100%); however, CT had low sensitivity for other soft tissue injuries of the knee.[47] In a second prospective study, the overall accuracy rates for diagnosing a meniscal tear were 82%-88% with MR arthrography and 74%-76% with CT arthrography. The authors concluded that CT arthrography was moderately accurate in the diagnosis of meniscal tears and can be used as an alternative procedure when MR arthrography cannot be completed.[48] An older retrospective study confirmed that multidetector CT can detect an intact ACL and posterior cruciate ligament with good specificity, accuracy, and negative predictive value, but assessment of torn ligaments is unreliable.[49] In general, spiral CT arthrography is an alternative for assessing internal derangements of the knee when MRI is unavailable or contraindicated.[42]

MRI is considered the gold standard for detection of internal derangement of the knee. A meta-analysis of 13 studies with 1197 patients assessed the evidence for the diagnostic efficacy of 3T MRI for meniscal and ACL injuries in the knee using arthroscopy as the reference standard. For medial meniscal injuries, mean sensitivity of 3T MRI was 0.94 (95% CI, 0.91-0.96) and mean specificity was 0.79 (95% CI, 0.75- 0.83). For detection of lateral meniscal injuries, 3T MRI had a mean sensitivity of 0.81 (95% CI, 0.75-0.85) and a mean specificity of 0.87 (95% CI, 0.84-0.89). Finally, for ACL injuries, 3T MRI had a mean sensitivity of 0.92 (95% CI, 0.83-0.96) and a mean specificity of 0.99 (95% CI, 0.96-1.00).[50] A 2016 systematic review and meta-analysis of 21 prospective studies with 1339 patients to determine the diagnostic accuracy of MRI and ultrasound in the diagnosis of ACL, medial meniscus and lateral meniscus tears in people with suspected ACL and/or meniscal tears. The results showed that a positive finding on MRI doubles the probability of an ACL tear across all clinical settings from 35.7% (95% CI, 25.9%-45.5%) to 85.8% (95% CI, 82.0%-90.0%). The estimated sensitivity and specificity of MRI were 87% (95% CI, 77%-94%) and 93% (95% CI, 91%-96%) for ACL tears, 89% (95% CI, 83%-94%) and 88% (95% CI, 82%-93%) for medial meniscal tears, and 78% (95% CI, 66%-87%) and 95% (95% CI, 91%-97%) for lateral meniscal tears. The sensitivity of MRI for lateral meniscal tears was lower than for ACL and medial meniscal tears but the specificity was higher.[51]

Miscellaneous Conditions

Avascular necrosis

Advanced imaging is considered medically necessary for diagnosis and management following nondiagnostic radiographs.

IMAGING STUDY

- MRI upper extremity (joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

Avascular necrosis or osteonecrosis is a form of ischemic bone necrosis due to vascular insufficiency. In 60%-75% of cases, avascular necrosis is associated with sickle cell disease, steroid use, alcoholism, chemoradiation, or metabolic bone disease.[42] Accurate grading is important for treatment as more advanced stages tend to require surgical intervention whereas medical treatments are favored in earlier stages. When initial radiographs demonstrate avascular necrosis and additional information is needed to guide treatment, MRI without IV contrast is usually appropriate.[45] Consensus among high-quality evidence-based guidelines also suggests that additional MRI imaging for avascular necrosis is also indicated in high-risk patients when radiographs are normal or inconclusive. Bone scan or CT may be substituted when MRI is not available.[42]

Few studies have directly compared the accuracy of MRI and CT in the diagnosis of avascular necrosis, and most of these studies focus on the hip. Those findings are likely applicable to other joints as the disease process is similar. While consensus favors MRI, and MRI has the added benefit of not using ionizing radiation, CT may be more sensitive in detecting subchondral fractures than MRI (MRI had a relative sensitivity of 38% compared to CT for subchondral fracture detection).[52]

Chronic anterior knee pain (including chondromalacia patella and patellofemoral pain syndrome)

Advanced imaging is considered medically necessary following nondiagnostic radiographs when **BOTH** of the following criteria are met:

- Chronic anterior knee pain not attributable to a specific injury
- Failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Hemarthrosis

Advanced imaging is considered medically necessary following arthrocentesis (except where contraindicated) when imaging is required to guide management.

IMAGING STUDY

- CT upper extremity; CT lower extremity
- MRI upper extremity (joint); MRI lower extremity

Rationale

Both CT and MRI may be useful in the evaluation of hemarthrosis. In the setting of trauma, CT may be useful to detect an underlying fracture. Both of these modalities can be useful in evaluating the extent of hemophilic pseudotumor. To evaluate changes of hemophilic arthropathy in early stages of the disease, when treatment may be most beneficial, MRI is preferable.[53]

Intra-articular loose body

Advanced imaging is considered medically necessary for diagnosis and management in patients with mechanical symptoms **AND** when radiographs are nondiagnostic.

IMAGING STUDY

- CT upper extremity; CT lower extremity
- MRI upper extremity (joint); MRI lower extremity

Rationale

Both CT arthrography and MRI showed excellent sensitivity (92%-100%) but lower specificity (15%-77%) for detecting posteriorly located loose bodies in the elbow. Neither MRI nor CT arthrography showed adequate sensitivity (46%-91%) or specificity (13%-73%) for evaluating anterior loose bodies. Overall, the sensitivity (80%-100%) and specificity (20%-70%) of MRI and CT arthrography were similar to those of radiography, which had a sensitivity of 84% and specificity of 71%.[54]

In both primary and secondary synovial chondromatosis, radiographs reveal multiple intraarticular calcifications. They tend to be more numerous and more uniform in size, shape, and distribution in primary synovial chondromatosis. CT is the optimal modality to characterize these loose bodies. The appearance of the loose bodies is more variable on MRI, with differences depending on the degree of calcification. However, MRI delineates the extent of disease well.[55]

Legg-Calve-Perthes disease (Pediatric only)

Refers to osteonecrosis of bony epiphysis in femoral heads, usually in patients age 4 to 10

Advanced imaging is considered medically necessary for diagnosis and management when radiographs are nondiagnostic.

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Osteochondral lesion (including osteochondritis dissecans, transient dislocation of patella)

Advanced imaging is considered medically necessary following nondiagnostic radiographs.

IMAGING STUDY

- MRI upper extremity (joint); MRI lower extremity
- CT upper or lower extremity when MRI cannot be performed or is nondiagnostic

Rationale

MR arthrography is reportedly more accurate than standard MRI, both for the detection of loose bodies and for determining the stability of osteochondral lesions. When direct arthrography is done, a lesion is considered to be unstable if there is insinuation of contrast between the lesion and its parent bone.[56]

Paget disease

Advanced imaging is considered medically necessary for management of disease in **ANY** of the following scenarios:

- Determine extent of disease in patients with suggestive findings on radiography
- Monitor response to therapy in patients with normal baseline bone turnover markers
- Evaluate for malignant transformation of Pagetoid lesions

IMAGING STUDY

- CT upper extremity; CT lower extremity to evaluate for malignant transformation
- MRI upper extremity (joint or non-joint); MRI lower extremity to evaluate for malignant

Rationale

Paget disease of bone is a metabolic bone disease characterized by non inflammatory osteoclastic activity followed by osteoblastic activity.[57] The disease can be mono- or polyostotic. CT or MRI may be indicated when malignant transformation of a Pagetoid lesion is suspected based on suspicious imaging or clinical findings.

Slipped capital femoral epiphysis (Pediatric only)

Note: Atraumatic fracture through the physeal plate is typically seen in overweight teenagers

Advanced imaging is considered medically necessary for diagnosis and management following nondiagnostic radiographs.

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Neurogenic Conditions

Brachial plexopathy

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- MRI upper extremity (non-joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Entrapment neuropathy (excluding carpal and cubital tunnel)

Advanced imaging is considered medically necessary when **ALL** of the following criteria are met:

- The diagnosis is confirmed by electromyography
- Failure of conservative management, unless objective weakness on exam

IMAGING STUDY

- MRI upper extremity (joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Neuropathic osteoarthropathy (Charcot joint) (Adult only)

Advanced imaging is considered medically necessary for diagnosis and management following nondiagnostic radiographs.

IMAGING STUDY

- CT upper extremity; CT lower extremity
- MRI upper extremity (joint); MRI lower extremity

Rationale

The early radiographic findings are similar to those of osteoarthritis. In more advanced disease, additional changes include subluxation, subchondral bone loss or fragmentation, sclerosis, osteophytosis, and intraarticular bone fragments.

The decision to perform CT or MRI is dependent upon the specific clinical concerns. For evaluation of subluxation and cortical or subcortical bone, CT may be preferable. If there is concern for underlying infection, MRI may be preferred.

Tarsal tunnel

Advanced imaging is considered medically necessary when **BOTH** of the following requirements are met:

- Following confirmation by electromyography and nerve conduction study
- Failure of at least 4 weeks of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Pain, unspecified

Applies to conditions not otherwise referenced in the Extremity guidelines

Non-specific hip pain, including limping child (Pediatric only)

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Evaluation of a limp in patients under 5 years of age, following nondiagnostic radiographs and ultrasound
- In patients age 5 years or older, following nondiagnostic radiographs and a failure of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Lower extremity pain, not otherwise specified

Excludes knee joint and hip joint. Applies when focused history and physical exam have not provided a likely diagnosis.

Advanced imaging is considered medically necessary for persistent pain when **BOTH** of the following criteria are met:

- Radiographs are nondiagnostic (without moderate/severe osteoarthritis or normal)
- Failure of at least 6 weeks of conservative management

IMAGING STUDY

- MRI lower extremity
- CT lower extremity when MRI cannot be performed or is nondiagnostic

Upper extremity pain, not otherwise specified

Excludes shoulder joint. Applies when focused history and physical exam have not provided a likely diagnosis.

Advanced imaging is considered medically necessary for persistent pain when **BOTH** of the following requirements are met:

- Radiographs are nondiagnostic (without moderate/severe osteoarthritis or normal)
- Failure of at least 6weeks of conservative management

Note: This requirement may be waived when significant objective muscle weakness across a joint has been demonstrated.

IMAGING STUDY

- MRI upper extremity (joint or non-joint)
- CT upper extremity when MRI cannot be performed or is nondiagnostic

Rationale

A focused history and physical may lead to a diagnosis in about 70% of cases. When imaging is needed, radiographs are the first-line modality and should include postero-anterior and lateral views. If the diagnosis remains in doubt after radiography, further imaging is indicated. The appropriate study depends upon the primary clinical concerns, among advanced imaging modalities, CT can evaluate for fractures and articular subluxations that are radiographically occult, and MRI is preferred for evaluation of soft tissue injuries.[58]

Perioperative Imaging, unspecified

Shoulder arthroplasty, presurgical planning[MJ3]

Advanced imaging is not indicated for robotic-assisted shoulder arthroplasty.

Advanced imaging is considered medically necessary for evaluation in **ANY** of the following scenarios:

- For preoperative assessment of bone stock and bone version prior to shoulder arthroplasty
- For assessment of rotator cuff status to determine the surgical approach
- For planned reverse shoulder arthroplasty in **ANY** of the following scenarios:
    - Reconstruction after a tumor resection
    - Glenohumeral osteoarthritis with irreparable rotator cuff tear
    - Failed hemiarthroplasty
    - Failed total shoulder arthroplasty with non-repairable rotator cuff

- Shoulder fracture that is not repairable or cannot be reconstructed with other techniques
- Advanced joint disease of the shoulder with severe osteoarthritis, pain and loss of function for at least 6 months duration and not responsive to at least 6 weeks of conservative management

IMAGING STUDY

- MRI upper extremity (joint) for assessment of rotator cuff status or for planned reverse shoulder arthroplasty
- CT upper extremity (joint) for preoperative assessment of bone stock and bone version, or for planned reverse shoulder arthroplasty

Knee arthroplasty, presurgical planning

Advanced imaging is not indicated for conventional total knee arthroplasty

Note: Appropriateness of imaging is dependent on appropriateness of the technique. Please refer to the health plan medical policy/guidelines and federal/state coverage mandates applicable to these techniques which supersede AIM guidelines.

Advanced imaging may be medically necessary for knee arthroplasty with patient specific instrumentation or robotic assisted navigation when **BOTH** of the following criteria are met:

- Existing hardware precludes use of medullary guides
- Radiographs demonstrate diaphyseal deformity of the femur or tibia that precludes use of an external guide

IMAGING STUDY

- CT lower extremity
- MRI lower extremity

Rationale

Studies evaluating patient-specific instrumentation have found limited evidence for improved mechanical alignment relative to conventional total knee replacement. A large systematic review of 8 randomized control trials and 8 cohort studies concluded that patient-specific instrumentation does not improve the accuracy of alignment of the components in total knee replacement compared with conventional instrumentation.[59] A separate systematic review looked at 2739 knees and found more misalignment in the patient-specific instrumentation group than in the conventional total knee replacement group and no difference in rotational alignment.[60]

The American Academy of Orthopaedic Surgeons (AAOS) evidence-based guideline on surgical management of osteoarthritis of the knee recommends against using intraoperative navigation in total knee arthroplasty because there is no difference in outcomes or complications, citing strong evidence. They further state that, “New surgical navigation methods will need randomized controlled trials to determine their effectiveness.”[61]

Robotic assisted arthroplasty is a new surgical navigation method. The method employs a haptic assistive robotic arm to restrict cutting movements within volumes defined from the 3D surgical plan established by preoperative CT.[62] Similar to other forms of surgical assisted arthroplasty, CT is therefore integral to the procedure and the appropriateness of the CT follows the appropriateness of the procedure.

A systematic review and network meta-analysis of 34 randomized controlled trials (7289 patients and 7424 knees) found that there was higher radiological accuracy for computer-assisted and robotic-assisted surgery when compared to conventional knee arthroplasty, but no differences were found in clinical outcomes.[63] A systematic overview of ten meta-analyses compared robotic-assisted versus conventional UKA and TKA. In UKA, one meta-analysis found improved clinical scores with robotic-assisted UKA, one found reduced complication rates, three found extended operation times with robotic-assisted UKA, and three found improved component positioning and alignment. In TKA, two studies found improved clinical scores and two found extended surgery times with robotic-assisted surgery, while five found improved component positioning and alignment. None of the included meta-analyses reported differences in survivorship when comparing conventional and robotic-assisted knee arthroplasty. The authors further noted, “six of the ten meta-analyses were of ‘critically low quality,’ calling for caution when interpreting results.”[64]

A randomized controlled trial of 1406 patients followed patients for a minimum of ten years after knee arthroplasty. 700 patients (750 knees) received robotic-assisted TKA and 706 patients (766 knees) received conventional knee arthroplasty. In terms of functional outcome scores, aseptic loosening, overall survivorship, and complications, the authors found no significant differences between conventional knee arthroplasty and robotic-assisted arthroplasty. Similar findings were seen in other RCTs.[65, 66]

The body of randomized evidence specific to MAKO is limited. For MAKO-assisted TKA, a 2021 prospective randomized controlled trial found that there is some reduction in systemic inflammatory markers at 7 days postoperatively, compared to conventional knee arthroplasty. No significant reductions were noted at 6 hours, 1 day, 2 days, or 28 days, however, and therefore the significance of this transient reduction is unclear.[67] No randomized data has been identified regarding the effect of MAKO-assisted TKA on patient-centered outcomes, compared to conventional knee arthroplasty.

For MAKO assisted UKA, a 2016 randomized controlled trial was done to evaluate robotic-assisted unicompartmental knee arthroplasty compared to conventional unicompartmental knee arthroplasty, with implant positioning as the primary endpoint. This study demonstrated increased accuracy of implant positioning but did not address patient-centered outcomes. A multi year exploratory study found no significant differences in numerous patient reported outcomes including UCLA score, Oxford Knee Score, American knee score, and several others.[68] There were also no differences in revision and complication rates. Only reintervention rate was significant at a single timepoint and based on an absolute difference of 4 cases. The authors concluded that “Larger multicentre studies, combined with registry data, in the future should provide sufficient data on large enough numbers of patients to allow robust sub-group analyses to determine which patients benefit most from the technology.” [62]

The body of non-randomized data on MAKO/robotic assist is also inconsistent. Some authors find short term and immediate post operative improvements in pain scores and function, but the findings are not consistent and may not exceed the minimum clinically important difference.[69-74]

Follow up data beyond a year is limited. The limited availability of randomized data and inconsistent non-randomized data supports with the conclusion from numerous systematic reviews (including those specific to MAKO)[64, 71, 75-84] that further well designed mid and long term outcome studies are needed to establish the efficacy of this technology relative to conventional arthroplasty.

Perioperative Imaging (including delayed hardware failure), not otherwise specified

Includes conditions not otherwise referenced in the Extremity Imaging guidelines. Advanced imaging is not indicated for robotic-assisted hip arthroplasty.

Note: Appropriateness of imaging is dependent on appropriateness of the technique. Please refer to the health plan medical policy/guidelines and federal/state coverage mandates applicable to these techniques which supersede AIM guidelines.

Advanced imaging is considered medically necessary following nondiagnostic radiographs or ultrasound.

IMAGING STUDY

- CT upper or lower extremity
- MRI upper extremity (joint or non-joint); MRI lower extremity

Rationale

ROBOTIC-ASSISTED HIP ARTHROPLASTY

Robotic assisted arthroplasty is a new surgical navigation method. The method employs a haptic assistive robotic arm to restrict cutting movements within volumes defined from the 3D surgical plan established by preoperative CT.[62] Similar to other forms of surgical assisted arthroplasty, CT is therefore integral to the procedure and the appropriateness of the CT follows the appropriateness of the procedure.

The body of non-randomized data on MAKO/robotic assist is also inconsistent. Some authors find short term and immediate post operative improvements in pain scores and function, but the findings are not consistent and may not exceed the minimum clinically important difference.[69-74]

The body of evidence related specifically to robotic-assisted hip arthroplasty is limited. A systematic review to 2020 finds low level evidence for an improved Harris hip score in patients having rTHA compared to those having a conventional arthroplasty; however, no long-term data is available.[85] A second systematic review to 2021 finds no significant difference in functional outcomes or complication rates when comparing robotic THA to manual THA.[86] Both systematic reviews note significant heterogeneity in the data.

Follow up data beyond a year is limited. The limited availability of randomized data and inconsistent non-randomized data supports with the conclusion from numerous systematic reviews (including those specific to MAKO)[64, 71, 75-84] that further well designed mid and long term outcome studies are needed to establish the efficacy of this technology relative to conventional arthroplasty.

References

1. Lawrence DA, Rolen MF, Haims AH, et al. Tarsal coalitions: radiographic, CT, and MR imaging findings. HSS J. 2014;10(2):153-66.
2. Crim JR, Kjeldsberg KM. Radiographic diagnosis of tarsal coalition. AJR Am J Roentgenol. 2004;182(2):323-8.

3. Iyer RS, Thapa MM. MR imaging of the paediatric foot and ankle. Pediatr Radiol. 2013;43 Suppl 1:S107-19.
4. Pineda C, Vargas A, Rodriguez AV. Imaging of osteomyelitis: current concepts. Infect Dis Clin North Am. 2006;20(4):789-825.
5. Hatzenbuehler J, Pulling TJ. Diagnosis and management of osteomyelitis. Am Fam Physician. 2011;84(9):1027-33.
6. Beaman FD, von Herrmann PF, Kransdorf MJ, et al. ACR Appropriateness Criteria suspected osteomyelitis, septic arthritis, or soft tissue infection (excluding spine and diabetic foot). J Am Coll Radiol. 2017;14(5s):S326-s37.
7. Coakley G, Mathews C, Field M, et al. BSR & BHPR, BOA, RCGP and BSAC guidelines for management of the hot swollen joint in adults. Rheumatology (Oxford). 2006;45(8):1039-41.
8. American College of Radiology, Society of Pediatric Radiology, Society of Skeletal Radiology, ACR–SPR–SSR practice parameter for the performance and interpretation of magnetic resonance imaging (MRI) of the Knee, (2015), American College of Radiology, 15.
9. Brower AC. Septic arthritis. Radiol Clin North Am. 1996;34(2):293-309, x.
10. Chauvin NA, Khwaja A. Imaging of inflammatory arthritis in children. Rheum Dis Clin North Am. 2016;42(4):587-606.
11. Royal Australian College of General Practitioners, Clinical guideline for the diagnosis and management of juvenile idiopathic arthritis, (2009) South Melbourne, AU, Royal Australian College of General Practitioners, 43.
12. Colebatch-Bourn AN, Edwards CJ, Collado P, et al. EULAR-PReS points to consider for the use of imaging in the diagnosis and management of juvenile idiopathic arthritis in clinical practice. Ann Rheum Dis. 2015;74(11):1946-57.
13. Taljanovic MS, Hunter TB, Fitzpatrick KA, et al. Musculoskeletal magnetic resonance imaging: importance of radiography. Skeletal Radiol. 2003;32(7):403-11.
14. Wright AA, Hegedus EJ, Lenchik L, et al. Diagnostic accuracy of various imaging modalities for suspected lower extremity stress fractures: a systematic review with evidence-based recommendations for clinical practice. Am J Sports Med. 2016;44(1):255-63.
15. McInnis KC, Ramey LN. High-risk stress fractures: diagnosis and management. Pm r. 2016;8(3 Suppl):S113-24.
16. Pegrum J, Dixit V, Padhiar N, et al. The pathophysiology, diagnosis, and management of foot stress fractures. Phys Sportsmed. 2014;42(4):87-99.
17. Mann JA, Pedowitz DI. Evaluation and treatment of navicular stress fractures, including nonunions, revision surgery, and persistent pain after treatment. Foot Ankle Clin. 2009;14(2):187-204.
18. Carpenter CR, Pines JM, Schuur JD, et al. Adult scaphoid fracture. Acad Emerg Med. 2014;21(2):101-21.
19. Roberts KC, Brox WT. AAOS Clinical Practice Guideline: management of hip fractures in the elderly. J Am Acad Orthop Surg. 2015;23(2):138-40.
20. Scottish Intercollegiate Guidelines Network, Management of hip fracture in older people: a national clinical guideline, (2009) Edinburgh, UK, Scottish Intercollegiate Guidelines Network, 56 pgs.
21. Collin D, Geijer M, Gothlin JH. Computed tomography compared to magnetic resonance imaging in occult or suspect hip fractures. A retrospective study in 44 patients. Eur Radiol. 2016;26(11):3932-8.
22. Murphey MD, Rhee JH, Lewis RB, et al. Pigmented villonodular synovitis: radiologic-pathologic correlation. Radiographics. 2008;28(5):1493-518.
23. Herman AM, Marzo JM. Popliteal cysts: a current review. Orthopedics. 2014;37(8):e678-84.
24. Mallinson PI, Chou H, Forster BB, et al. Radiology of soft tissue tumors. Surg Oncol Clin N Am. 2014;23(4):911-36.
25. Jernigan EW, Esther RJ. Soft tissue masses for the general orthopedic surgeon. Orthop Clin North Am. 2015;46(3):417-28, xi.
26. Bussieres AE, Peterson C, Taylor JA. Diagnostic imaging guideline for musculoskeletal complaints in adults-an evidence-based approach-part 2: upper extremity disorders. J Manipulative Physiol Ther. 2008;31(1):2-32.
27. Arirachakaran A, Boonard M, Chaijenkij K, et al. A systematic review and meta-analysis of diagnostic test of MRA versus MRI for detection superior labrum anterior to posterior lesions type II-VII. Skeletal Radiol. 2017;46(2):149-60.
28. Smith T, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. Arch Orthop Trauma Surg. 2012;132(7):905-19.
29. Acid S, Le Corroller T, Aswad R, et al. Preoperative imaging of anterior shoulder instability: diagnostic effectiveness of MDCT arthrography and comparison with MR arthrography and arthroscopy. AJR Am J Roentgenol. 2012;198(3):661-7.

30. Washington State Department of Labor and Industries, Shoulder conditions diagnosis and treatment guideline, (2013) Olympia WA, Washington State Department of Labor and Industries, 28 pgs.
31. Bak K. The practical management of swimmer's painful shoulder: etiology, diagnosis, and treatment. Clin J Sport Med. 2010;20(5):386-90.
32. Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria imaging after shoulder arthroplasty. J Am Coll Radiol. 2016;13(11):1324-36.
33. Colorado Division of Workers' Compensation, Shoulder injury medical treatment guidelines, (2014) Denver, CO, Colorado Department of Labor and Employment Division of Workers' Compensation, 234 pgs.
34. Hopman K, University of New South Wales, Clinical practice guidelines for the management of rotator cuff syndrome in the workplace, (2013) Port Macquarie, AU, University of New South Wales, 80 pgs.
35. Roy JS, Braen C, Leblond J, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. Br J Sports Med. 2015;49(20):1316-28.
36. Handoll H, Hanchard N, Lenza M, et al. Rotator cuff tears and shoulder impingement: a tale of two diagnostic test accuracy reviews. Cochrane Database of Systematic Reviews. 2013(10):ED000068.
37. Lenza M, Buchbinder R, Takwoingi Y, et al. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. Cochrane Database Syst Rev. 2013(9):Cd009020.
38. Schmid MR, Schertler T, Pfirrmann CW, et al. Interosseous ligament tears of the wrist: comparison of multi-detector row CT arthrography and MR imaging. Radiology. 2005;237(3):1008-13.
39. Mintz DN, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria chronic hip pain. J Am Coll Radiol. 2017;14(5s):S90-s102.
40. Enseki K, Harris-Hayes M, White DM, et al. Nonarthritic hip joint pain. J Orthop Sports Phys Ther. 2014;44(6):A1-32.
41. Smith T, Simpson M, Ejindu V, et al. The diagnostic test accuracy of magnetic resonance imaging, magnetic resonance arthrography and computer tomography in the detection of chondral lesions of the hip. Eur J Orthop Surg Traumatol. 2013;23(3):335-44.
42. Bussieres AE, Taylor JA, Peterson C. Diagnostic imaging practice guidelines for musculoskeletal complaints in adults--an evidence-based approach. Part 1. Lower extremity disorders. J Manipulative Physiol Ther. 2007;30(9):684-717.
43. Beaufils P, Hulet C, Dhenain M, et al. Clinical practice guidelines for the management of meniscal lesions and isolated lesions of the anterior cruciate ligament of the knee in adults. Orthop Traumatol Surg Res. 2009;95(6):437-42.
44. Karel YH, Verkerk K, Endenburg S, et al. Effect of routine diagnostic imaging for patients with musculoskeletal disorders: A meta-analysis. Eur J Intern Med. 2015;26(8):585-95.
45. Taljanovic MS, Chang EY, Ha AS, et al. ACR Appropriateness Criteria acute trauma to the knee. J Am Coll Radiol. 2020;17(5):S12-S25.
46. Shea KG, Carey JL, Richmond J, et al. The American Academy of Orthopaedic Surgeons evidence-based guideline on management of anterior cruciate ligament injuries. J Bone Joint Surg Am. 2015;97(8):672-4.
47. Heffernan EJ, Moran DE, Gerstenmaier JF, et al. Accuracy of 64-section MDCT in the diagnosis of cruciate ligament tears. Clin Radiol. 2017;72(7):611.e1-.e8.
48. Fox MG, Graham JA, Skelton BW, et al. Prospective evaluation of agreement and accuracy in the diagnosis of meniscal tears: MR arthrography a short time after injection versus CT arthrography after a moderate delay. AJR Am J Roentgenol. 2016;207(1):142-9.
49. Mustonen AO, Koivikko MP, Haapamaki VV, et al. Multidetector computed tomography in acute knee injuries: assessment of cruciate ligaments with magnetic resonance imaging correlation. Acta Radiol. 2007;48(1):104-11.
50. Smith C, McGarvey C, Harb Z, et al. Diagnostic efficacy of 3-T MRI for knee injuries using arthroscopy as a reference standard: a meta-analysis. AJR Am J Roentgenol. 2016;207(2):369-77.
51. Phelan N, Rowland P, Galvin R, et al. A systematic review and meta-analysis of the diagnostic accuracy of MRI for suspected ACL and meniscal tears of the knee. Knee Surg Sports Traumatol Arthrosc. 2016;24(5):1525-39.
52. Stevens K, Tao C, Lee SU, et al. Subchondral fractures in osteonecrosis of the femoral head: comparison of radiography, CT, and MR imaging. AJR Am J Roentgenol. 2003;180(2):363-8.
53. Kerr R. Imaging of musculoskeletal complications of hemophilia. Semin Musculoskelet Radiol. 2003;7(2):127-36.
54. Dubberley JH, Faber KJ, Patterson SD, et al. The detection of loose bodies in the elbow: the value of MRI and CT arthrography. J Bone Joint Surg Br. 2005;87(5):684-6.

55. Murphey MD, Vidal JA, Fanburg-Smith JC, et al. Imaging of synovial chondromatosis with radiologic-pathologic correlation. Radiographics. 2007;27(5):1465-88.
56. Durur-Subasi I, Durur-Karakaya A, Yildirim OS. Osteochondral lesions of major joints. Eurasian J Med. 2015;47(2):138-44.
57. Nebot Valenzuela E, Pietschmann P. Epidemiology and pathology of Paget's disease of bone - a review. Wien Med Wochenschr. 2017;167(1-2):2-8.
58. Forman TA, Forman SK, Rose NE. A clinical approach to diagnosing wrist pain. Am Fam Physician. 2005;72(9):1753-8.
59. Thienpont E, Schwab PE, Fennema P. A systematic review and meta-analysis of patient-specific instrumentation for improving alignment of the components in total knee replacement. Bone Joint J. 2014;96-b(8):1052-61.
60. Zhang Q, Chen JY, Li H, et al. No evidence of superiority in reducing outliers of component alignment for patient-specific instrumentation for total knee arthroplasty: a systematic review. Orthop Surg. 2015;7(1):19-25.
61. American Academy of Orthopedic Surgeons, Surgical management of osteoarthritis of the knee: evidence-based clinical practice guideline (2015) Rosemont (IL), American Academy of Orthopaedic Surgeons, 669 pgs.
62. Banger M, Doonan J, Rowe P, et al. Robotic arm-assisted versus conventional medial unicompartmental knee arthroplasty: five-year clinical outcomes of a randomized controlled trial. Bone Joint J. 2021;103-B(6):1088-95.
63. Gao J, Dong S, Li JJ, et al. New technology-based assistive techniques in total knee arthroplasty: a Bayesian network meta-analysis and systematic review. Int J Med Robot. 2020:e2189.
64. Kort N, Stirling P, Pilot P, et al. Robot-assisted knee arthroplasty improves component positioning and alignment, but results are inconclusive on whether it improves clinical scores or reduces complications and revisions: a systematic overview of meta-analyses. Knee Surg Sports Traumatol Arthrosc. 2021;05:05.
65. Kim YH, Yoon SH, Park JW. Does robotic-assisted TKA result in better outcome scores or long-term survivorship than conventional TKA? A randomized, controlled trial. Clin Orthop Relat Res. 2020;478(2):266-75.
66. Liow MHL, Goh GS, Wong MK, et al. Robotic-assisted total knee arthroplasty may lead to improvement in quality-of-life measures: a 2-year follow-up of a prospective randomized trial. Knee Surg Sports Traumatol Arthrosc. 2017;25(9):2942-51.
67. Kayani B, Tahmassebi J, Ayuob A, et al. A prospective randomized controlled trial comparing the systemic inflammatory response in conventional jig-based total knee arthroplasty versus robotic-arm assisted total knee arthroplasty. Bone Joint J. 2021;103-B(1):113-22.
68. Gilmour A, MacLean AD, Rowe PJ, et al. Robotic-arm-assisted vs conventional unicompartmental knee arthroplasty. The 2-year clinical outcomes of a randomized controlled trial. J Arthroplasty. 2018;33(7S):S109-S15.
69. Clement ND, Bell A, Simpson P, et al. Robotic-assisted unicompartmental knee arthroplasty has a greater early functional outcome when compared to manual total knee arthroplasty for isolated medial compartment arthritis. Bone Joint Res. 2020;9(1):15-22.
70. Negrin R, Duboy J, Iniguez M, et al. Robotic-assisted vs conventional surgery in medial unicompartmental knee arthroplasty: a clinical and radiological study. Knee Surg Relat Res. 2021;33(1):5.
71. Kayani B, Konan S, Ayuob A, et al. Robotic technology in total knee arthroplasty: a systematic review. EFORT Open Rev. 2019;4(10):611-7.
72. Khlopas A, Sodhi N, Hozack WJ, et al. Patient-reported functional and satisfaction outcomes after robotic-arm-assisted total knee arthroplasty: early results of a prospective multicenter investigation. J Knee Surg. 2020;33(7):685-90.
73. Smith AF, Eccles CJ, Bhimani SJ, et al. Improved patient satisfaction following robotic-assisted total knee arthroplasty. J Knee Surg. 2021;34(7):730-8.
74. Shaw JH, Lindsay-Rivera KG, Buckley PJ, et al. Minimal clinically important difference in robotic-assisted total knee arthroplasty versus standard manual total knee arthroplasty. J Arthroplasty. 2021;36(7S):S233-S41.
75. Robinson PG, Clement ND, Hamilton D, et al. A systematic review of robotic-assisted unicompartmental knee arthroplasty: prosthesis design and type should be reported. Bone Joint J. 2019;101-B(7):838-47.
76. Zhang J, Ndou WS, Ng N, et al. Robotic-arm assisted total knee arthroplasty is associated with improved accuracy and patient reported outcomes: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2021;06:06.
77. Lin J, Yan S, Ye Z, et al. A systematic review of MAKO-assisted unicompartmental knee arthroplasty. Int J Med Robot. 2020;16(5):1-7.
78. Karunaratne S, Duan M, Pappas E, et al. The effectiveness of robotic hip and knee arthroplasty on patient-reported outcomes: a systematic review and meta-analysis. Int Orthop. 2019;43(6):1283-95.

79. Negrin R, Ferrer G, Iniguez M, et al. Robotic-assisted surgery in medial unicompartmental knee arthroplasty: does it improve the precision of the surgery and its clinical outcomes? Systematic review. J Robot Surg. 2021;15(2):165-77.

80. Batailler C, Fernandez A, Swan J, et al. MAKO CT-based robotic arm-assisted system is a reliable procedure for total knee arthroplasty: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2021;29(11):3585-98.

81. Gaudiani MA, Samuel LT, Kamath AF, et al. Robotic-assisted versus manual unicompartmental knee arthroplasty: contemporary systematic review and meta-analysis of early functional outcomes. J Knee Surg. 2021;34(10):1048-56.

82. Mancino F, Cacciola G, Malahias MA, et al. What are the benefits of robotic-assisted total knee arthroplasty over conventional manual total knee arthroplasty? A systematic review of comparative studies. Orthop Rev (Pavia). 2020;12(Suppl 1):8657.

83. Onggo JR, Onggo JD, De Steiger R, et al. Robotic-assisted total knee arthroplasty is comparable to conventional total knee arthroplasty: a meta-analysis and systematic review. Arch Orthop Trauma Surg. 2020;140(10):1533-49.

84. Bouche PA, Corsia S, Dechartres A, et al. Are there differences in accuracy or outcomes scores among navigated, robotic, patient-specific instruments or standard cutting guides in TKA? A network meta-analysis. Clin Orthop Relat Res. 2020;478(9):2105-16.

85. Ng N, Gaston P, Simpson PM, et al. Robotic arm-assisted versus manual total hip arthroplasty: a systematic review and meta-analysis. Bone Joint J. 2021;103-b(6):1009-20.

86. Samuel LT, Acuña AJ, Mahmood B, et al. Comparing early and mid-term outcomes between robotic-arm assisted and manual total hip arthroplasty: a systematic review. J Robot Surg. 2022;16(4):735-48.

Codes

The following code list is not meant to be all-inclusive. Authorization requirements will vary by health plan. Please consult the applicable health plan for guidance on specific procedure codes.

Specific CPT codes for services should be used when available. Nonspecific or not otherwise classified codes may be subject to additional documentation requirements and review.

CPT/HCPCS

73200 ....CT upper extremity, without contrast

73201 ....CT upper extremity, with contrast

73202 ....CT upper extremity, without contrast, followed by re-imaging with contrast

73218 ....MRI upper extremity non-joint, without contrast

73219 ....MRI upper extremity non-joint, with contrast

73220 ....MRI upper extremity non-joint, without contrast, followed by re-imaging with contrast

73221 ....MRI upper extremity any joint, without contrast

73222 ....MRI upper extremity any joint, with contrast

73223 ....MRI upper extremity any joint, without contrast, followed by re-imaging with contrast

73700 ....CT lower extremity, without contrast

73701 ....CT lower extremity, with contrast

73702 ....CT lower extremity, without contrast, followed by re-imaging with contrast

73718 ....MRI lower extremity non-joint, without contrast

73719 ....MRI lower extremity non-joint, with contrast

73720 ....MRI lower extremity non-joint, without contrast, followed by re-imaging with contrast

73721 ....MRI lower extremity any joint, without contrast

73722 ....MRI lower extremity any joint, with contrast

73723 ....MRI lower extremity any joint, without contrast, followed by re-imaging with contrast

78811 ....PET imaging, limited area

78812 ....PET imaging, skull to mid-thigh

78813 ....PET imaging, whole body

78814 ....PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; limited area

78815 ....PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; skull base to mid-thigh

78816 ....PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; whole body

G0235 ....PET imaging, any site, not otherwise specified

S8085............Fluorine-18 fluorodeoxyglucose (f-18 fdg) imaging using dual-head coincidence detection system (non-dedicated PET scan)

ICD-10 Diagnosis

Refer to the ICD-10 CM manual

History

Status	Review Date	Effective Date	Action
Revised	01/24/2023	09/10/2023	Independent Multispecialty Physician Panel (IMPP) review. Revised indications: Traumatic injuries – acute/not otherwise specified, Fracture, and Shoulder arthroplasty, presurgical planning.
Revised	11/11/2021	09/11/2022	IMPP review. Revised general prerequisites for extremity imaging and these indications: Plantar fasciitis and fibromatosis, Fracture, Rotator cuff tear, Chronic anterior knee pain (including chondromalacia patella and patellofemoral pain syndrome), Shoulder arthroplasty, presurgical planning, and Perioperative Imaging (including delayed hardware failure), not otherwise specified.
Revised	12/03/2020	09/12/2021	IMPP review. Revised definitions, general prerequisites for extremity imaging, and these indications: Soft tissue infection, Osteomyelitis or septic arthritis, picondylitis, Myositis, Plantar fasciitis, Tenosynovitis – long head of biceps, Fracture, Brachial plexus mass, Morton's neuroma, Adhesive capsulitis, Labral tear—shoulder, Ligament and tendon injuries- upper extremity, not listed elsewhere, Rotator cuff tear, Triangular fibrocartilage complex tear, Ulnar collateral ligment tear (elbow or thumb), Labral tear and femoral acetabular impingement—hip, Ligament tear—knee, Ligament and tendon injury and rupture- foot and ankle, Avascular necrosis, Chronic anterior knee pain (including Chondromalacia patella and patellofemoral pain syndrome), Intra-articular loose body, Osteochondral lesion (including osteochondritis dissecans, transient dislocation of patella), Entrapment neuropathy (excluding carpal and cubital tunnel), Lower extremity pain, not otherwise specified, Upper extremity pain, not otherwise specified, Reverse shoulder arthroplasty, Knee arthroplasty, presurgical planning, Perioperative Imaging (including delayed hardware failure), not otherwise specified.
Revised	-	03/14/2021	Added HCPCS codes G0235 and S8085.
Reaffirmed	07/08/2020	Unchanged	IMPP review. Guideline reaffirmed.
Revised	01/28/2019	09/28/2019	IMPP review. Revised general prerequisites for extremity imaging and these indications: Congenital or developmental anomalies, Meniscal tear/injury, Soft tissue infection, Osteomyelitis or septic arthritis, Upper extremity pain, Capitellar osteochondritis, Fracture, Traumatic injuries—acute/not otherwise specified, Intraarticular loose body, Indeterminate bone lesion, Soft tissue mass—not otherwise specified, Labral tear—shoulder, Rotator cuff tear (adult), Labral tear—hip, Ligament tear—knee, Lisfranc injury, Meniscal tear/injury, Avascular necrosis, Paget's disease, Perioperative imaging.
Restructured	09/12/2018	01/01/2019	IMPP review. Advanced Imaging guidelines redesigned and reorganized to a condition-based structure. Incorporated AIM guidelines for pediatric imaging.
Revised	07/11/2018	03/09/2019	IMPP review. Renamed the Administrative Guidelines to "General Clinical Guideline." Retitled Pretest Requirements to "Clinical Appropriateness Framework" to summarize the components of a

Status	Review Date	Effective Date	Action
			decision to pursue diagnostic testing. Revised to expand applicability beyond diagnostic imaging, retitled Ordering of Multiple Studies to “Ordering of Multiple Diagnostic or Therapeutic Interventions” and replaced imaging-specific terms with “diagnostic or therapeutic intervention.” Repeated Imaging split into two subsections, “repeat diagnostic testing” and “repeat therapeutic intervention.”
Reaffirmed	09/22/2017	03/12/2018	Annual review.
Revised	07/26/2016	10/31/2016	IMPP review.
Created	-	03/30/2005	Original effective date.