

AmeriHealth Caritas Louisiana

National Imaging Associates, Inc.*	
Clinical guidelines LOWER EXTREMITY CT (Foot, Ankle, Knee, Leg or Hip CT)	Original Date: September 1997
CPT Codes: 73700, 73701, 73702	Last Revised Date: May 2020
Guideline Number: NIA_CG_057-2	Implementation Date: January 2021 <u>TBD</u>

GENERAL INFORMATION:

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results, and the reason that alternative imaging (gold standard, protocol, contrast, etc.) cannot be performed must be included in the documentation submitted.

INDICATIONS FOR LOWER EXTREMITY CT (FOOT, ANKLE, KNEE, LEG or HIP):

(Plain radiographs must precede CT evaluation)

Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time.

If a CT Arthrogram fits approvable criteria below, approve as CT

Joint specific provocative orthopedic examination when MRI is contraindicated or cannot be performed (see Table 1).

Note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging.

- Ankle
 - Positive drawer sign ≥ 4 days after injury (Vuurberg, 2018)
- Knee (Bennett, 2012; Doral, 2018; Katz, 2013; Mohankumar, 2014; Slaughter, 2014; Smith, 2015; Tuite, 2014)
 - Any positive test listed
 - McMurray's
 - Thessaly
 - Apley's
 - Lachman's

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- Anterior or Posterior Drawer sign
- Varus or valgus stress
- Acute mechanical locking of the knee not due to guarding (Hussin, 2014)

- Hip

- Anterior Impingement sign (labral tear) (Hananouchi, 2012; Naraghi, 2015; Ward, 2013)
- Posterior Impingement sign (labral tear) (Groh, 2009)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed and a MRI is contraindicated or cannot be performed (Katz, 2013; Mordecai, 2014) (does not apply to young children)

- Persistent joint or musculotendinous pain unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician supervised exercise**) of at least four (4) weeks, OR
- With progression or worsening of symptoms during the course of conservative treatment
- Persistent hip mechanical symptoms including clicking, locking, catching, giving way or hip instability with a clinical suspicion of labral tear, with or without clinical findings suggestive of impingement (Groh, 2009; Mintz, 2017)

Painful acquired or congenital flatfoot deformity in an adult, after x-ray completed and MRI is contraindicated

- After failure of active conservative therapy listed above (Abousayed, 2017; Thorpe, 2012)

Extremity Mass (Mullan 2011; Zoga, 2017)

- Peripheral lymphadenopathy that is unexplained by other diagnosis (eg. infection) possibly due to suspected malignancy of the extremity (Dommett, 2013; Gaddey, 2016; Mohseni, 2014)

- Any of these:

- Fixation to adjacent tissues
- Firm consistency
- Size >1.5 cm
- Ulceration of overlying skin
- Two or more regions

Persistence after 4 weeks

- Mass or lesion after non-diagnostic x-ray or ultrasound (Murphey, 2018) and MRI cannot be performed. Includes one follow-up if first study indeterminate-CT is better than MRI to evaluate mass calcification or bone involvement and may complement or replace MRI (Subhawong, 2010)
 - Baker's cyst should be initially evaluated with ultrasound
 - If superficial, then ultrasound is the initial study.
 - If deep, then x-ray is the initial study.

- **If there is a contraindication to MRI**
- ~~Mass with increased risk for malignancy including any of the following (Sinha, 2010):~~
 - ~~Soft tissue mass > 5 cm (golf ball size or larger)~~
 - ~~Painful lump not from injury~~
 - ~~Lump that is increasing in size~~
 - ~~A lump of any size that is deep to the muscle fascia~~
 - ~~Recurrence of a lump after previous excision~~
-

Known Cancer of the Extremity

(Fitzgerald, 2015; Holzapfel, 2015; Kircher, 2012; Morrison, 2013; [NCCN, 2019](#))

- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint [~~MRI is contraindicated or cannot be done (Lee, 2016)~~] (Beaman, 2017; Dodwell, 2013) ([Dodwell, 2013](#); [Glaudemans, 2019](#))

Note: MRI and nuclear medicine studies are recommended for acute infection as they are more sensitive in detecting early changes of osteomyelitis (Mandell, 2017). CT is better at demonstrating findings of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) as well as detecting soft tissue gas and foreign bodies (Fayad, 2007).

- Abnormal x-ray or ultrasound
- Negative x-ray but with a clinical suspicion of infection
 - Signs and symptoms of joint or bone infection include:
 - Pain and ~~localized findings~~swelling
 - Decrease range of motion
 - Fevers
 - Laboratory findings of infection include:
 - Elevated ESR or CRP
 - Elevated white blood cell count
 - Positive joint aspiration
- A suspicion of osteomyelitis of the foot in patients with diabetes (Walker, 2019)

Osteonecrosis (Avascular necrosis (AVN), Legg-Calve-Perthes Disease) when MRI is contraindicated or cannot be performed (Felten, 2019; Murphey, 2014; 2016)

- Abnormal x-ray
- Normal or indeterminate X-rays but symptomatic and high risk (e.g., glucocorticosteroid use, renal transplant recipient, glycogen storage disease, alcohol abuse (Fukushima, 2010), sickle cell anemia (Wali, 2011))

For evaluation of known or suspected autoimmune disease (e.g. rheumatoid arthritis) and MRI is contraindicated:

- Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
- Imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR) (Colebatch, 2013).
- To determine change in treatment or when diagnosis is uncertain prior to start of treatment (and MRI is contraindicated).

Crystalline Arthropathy

- Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017)

Trauma

Bone Fracture ~~or ligament injury~~

Clinical Concern for Occult or Stress Fracture based on all the following Suspected stress or insufficiency fracture with a negative initial x-ray (Berncardino, 2017; Patel, 2011; Sadineni, 2015):

- If hips and MRI cannot be done
- X rays initially and at ≥ 2 weeks are if other parts of the extremities and repeat x-rays in 10-14 are negative or non-diagnostic
- If at high risk for a complete fracture with conservative therapy and MRI cannot be done (Kellar, 2020)
- Persistent focal pain and tenderness despite treatment for this time interval:
 - Medications (analgesics and/or anti-inflammatory) AND
 - Activity modification with bracing where appropriate

~~Clinical concern for hip fracture with initial x rays negative or non-diagnostic (ACR 2018; Gill, 2013)~~

• Suspected acute hip fracture with initial x-rays negative or non-diagnostic (Gill, 2013; Ross, 2019)

• Intra articular fractures that may require surgery (i.e., depressed tibial plateau fracture) (Prat-Fabregat, 2017)

• Fracture on X-ray with documentation of how imaging will affect treatment (Scalcione, 2014)

• Nonunion or delayed union as demonstrated by no healing between two sets of x-rays. If a fracture has not healed by 4-6 months, there is delayed union. Incomplete healing by 6-8 months is nonunion (Morshed, 2014; Salih, 2015)

Tendon or Muscle Rupture after X-Ray -and MRI is contraindicated or cannot be done (Garras, 2012; Peck, 2017; Wilkins, 2012)

- Clinical suspicion based on mechanism of injury and physical findings

Suspected ACL Rupture - Acute knee injury with physical exam limited by pain and swelling with x-ray completed (Wheless, 2018) if MRI is contraindicated (ACR, 2019)

- Inability to perform because of pain and swelling should be considered a red flag
- Suspicion should be based on mechanism of injury, i.e., twisting, blunt force
- Normal x-ray:
 - Extreme pain, inability to stand, audible pop at time of injury, very swollen joint, leg numbness
- Abnormal x-ray:
 - Large joint effusion on x-ray knee effusion (Cecava, 2018)

~~Concern for fracture non union based on x rays and physical findings, at least three months after initial treatment (Salih, 2015; Rabinovich, 2015) (Joint or Muscle Pain, X-Ray Completed (x-ray first if patient is older than 5) (Katz, 2013; Mordecai, 2014, ACR 2018) (Includes tarsal Coalition and pes planus (Bouchard, 2014; Thorpe, 2012) when MRI is contraindicated or cannot be performed (Lefevre, 2016)~~

~~Chronic (lasting 3 months or greater) pain and/or persistent tendonitis unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician supervised exercise**) of at least four (4) weeks,~~

~~With progression or worsening of symptoms during the course of conservative treatment. Ordered as CT arthrogram when MR arthrogram is contraindicated or cannot be performed (Fox, 2016)~~

Osteochondral Lesions (defects, fractures, osteochondritis dissecans) and x-ray done (if MRI contraindicated or cannot be done)

(Mintz 2017; Smith, 2012; Tuite, 2014; Van Bergen, 2015; Van Dijk, 2010)

- Clinical suspicion based on mechanism of injury and physical findings

Foreign Body (Laya, 2017)

- Indeterminate x-ray and ultrasound

Loose bodies or synovial chondromatosis seen on x-ray or ultrasound

- In the setting of joint pain (Rajani, 2016)

Peripheral Nerve Entrapment when MRI is contraindicated, including any of the following:

(Domkundwar, 2017; Dong 2012; Donovan, 2010; Tos, 2015)

- Abnormal Electromyogram or Nerve conduction study
- Abnormal x-ray or ultrasound
- Clinical suspicion and failed 4 weeks conservative treatment including at least 2 of the following (active treatment with physical therapy is not required):
 - Activity modification
 - Rest, ice, or heat

- Splinting or orthotics
- Medication

Joint specific provocative orthopedic examination, after x-ray completed when MRI is contraindicated or cannot be performed

- ~~Ankle~~
 - ~~Positive drawer sign \geq 4 days after injury (Vuurberg, 2018)~~
- ~~Knee (Bennett, 2012; Doral, 2018; Katz, 2013; Slaughter, 2014; Smith, 2015; Mohankumar, 2014; Tuite, 2014)~~
 - ~~Any positive test list~~
 - ~~McMurray's~~
 - ~~Thessaly~~
 - ~~Joint Line Tenderness~~
 - ~~Apley's~~
 - ~~Lachman's~~
 - ~~Anterior or Posterior Drawer sign~~
 - ~~Varus or valgus stress~~
- ~~Hip, any positive test listed~~
 - ~~Slipped Capital Femoral Epiphysis (Hesper, 2017; Kamegaya, 2011; Peck, 2017)~~
 - ~~Drehman sign~~
 - ~~Limited internal rotation of the hip~~
 - ~~Anterior Impingement sign (labral tear) (Hananouchi, 2012, Naraghi, 2015; Ward, 2013)~~

~~Hemarthrosis on arthrocentesis or x-ray, any joint and MRI is contraindicated or cannot be done (Abbas, 2012; Bencardino, 2013; Turan, 2015)~~

Pediatrics:

- ~~**Note:** Leg length discrepancy – the literature indicates that standing plain film x-rays are preferred, but there are some advantages to using a CT scanogram instead and may be preferred (Guggenberger, 2014) (Guggenberger, 2014; Sabharwal, 2008)~~
- ~~Other indications Osteoid Osteoma after an x-ray is done (Iyer, 2012)~~
- ~~Painful flatfoot (Pes planus) deformity with suspected tarsal coalition, not responsive to active conservative care (Bouchard, 2014)~~
 - ~~When MRI cannot be done; **OR**~~
 - ~~Extra-articular coalition is suspected (bony bridges around the joints); **OR**~~
 - ~~When needed for surgical planning (Glaser, 2016)~~
- ~~Slipped Capital Femoral Epiphysis and Chronic Recurrent Multifocal Osteomyelitis – MRI is the appropriate modality, rather than CT~~

Pre-operative/procedural evaluation:

- Pre-operative evaluation for a planned surgery or procedure (See exclusions*)

*CT or MRI requests are *not* approvable for the following total knee arthroplasty (TKA) procedures:

- Procedures utilizing computer-navigated or patient-specific or gender-specific instrumentation (Johnson, 2011)
- Bicompartmental arthroplasty (investigational at this time) (Dudhniwala, 2016)
- ~~Note: Robot assisted TKA (MakoPlasty) (Banerjee, 2015; Nair, 2014)~~

These surgical procedures are not considered a covered service and are not reimbursable based on lack of current scientific evidence for clinically important improvement, safety or efficacy; or based on scientific evidence of increased risk of serious complications.

Post-operative/procedural evaluation:

- When imaging, physical, or laboratory findings indicate joint infection, delayed or non-healing, or other surgical/procedural complications.
- Joint prosthesis loosening or dysfunction, x-rays non-diagnostic (Fritz, 2014, 2015)

Table 1: Positive Orthopedic Joint Tests, Lower Extremity

ANKLE

- Posterior draw
- Thompson
- Thumb squeeze test
- Mulder click

HIP

- Trendelenburg

KNEE

- Anterior draw
- Pivot Shift Test
- Lachman
- Posterior tibial Sag
- Posterior Draw
- McMurray's Test
- Thessaly
- Valgus stress
- Varus stress

BACKGROUND:

Plain radiographs are typically used as the first-line modality for assessment of lower extremity conditions. Computed tomography (CT) is used for evaluation of tumors, metastatic lesions, infection, fractures, and other problems. Magnetic resonance imaging (MRI) is the first-line choice for imaging of many conditions, but CT may be used in these cases if MRI is contraindicated or unable to be performed.

OVERVIEW:

***Conservative Therapy:** (musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified activities, medical devices, (such as crutches, immobilizer, metal braces, orthotics, rigid stabilizer or splints, etc and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:

- Information provided on exercise prescription/plan AND
- Follow up with member with information provided regarding completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

Joint Implants and Hardware Dual-energy CT may be useful for metal artifact reduction if available, but is also imperfect as the correction is based on a projected approximation of x-ray absorption and it does not correct for scatter (Boas, 2012). Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017).

CT and Ankle Fractures – One of the most frequently injured areas of the skeleton is the ankle. These injuries may include ligament sprains, as well as fractures. A suspected fracture is first imaged with conventional radiographs in anteroposterior, internal oblique and lateral projections. CT is used in patients with complex ankle and foot fractures after radiography.

CT and Hip Trauma – Computed tomography is primarily used to evaluate acute trauma, e.g., acetabular fracture or hip dislocation. It can detect intraarticular fragments and associated articular surface fractures and it is useful in surgical planning.

CT and Knee Fractures – CT is used after plain films to evaluate fractures to the tibial plateau. These fractures occur just below the knee joint, involving the cartilage surface of the knee. Soft tissue injuries are usually associated with the fractures. The meniscus is a stabilizer of the knee and it is very important to detect meniscal injury in patients with tibial plateau fractures. CT of the knee with two-dimensional reconstruction in the sagittal and coronal planes may be performed for evaluation of injuries with multiple fragments and comminuted fractures. Spiral

CT has an advantage of rapid acquisition and reconstruction times and may improve the quality of images of bone. Soft tissue injuries are better demonstrated with MRI.

CT and Knee Infections – CT is used to depict early infection which may be evidenced by increased intraosseous density or the appearance of fragments of necrotic bone separated from living bone by soft tissue or fluid density. Contrast-enhanced CT may help in the visualization of abscesses and necrotic tissue.

CT and Knee Tumors – CT complements arthrography in diagnosing necrotic malignant soft-tissue tumors and other cysts and masses in the knee. Meniscal and ganglion cysts are palpable masses around the knee. CT is useful in evaluations of the vascular nature of lesions.

CT and Legg-Calve-Perthes Disease (LPD) – This childhood condition is associated with an insufficient blood supply to the femoral head which is then at risk for osteonecrosis. Clinical signs of LPD include a limp with groin, thigh or knee pain. Flexion and adduction contractures may develop as the disease progresses and eventually movement may only occur in the flexion-extension plane. This condition is staged based on plain radiographic findings. CT scans are used in the evaluation of LPD and can demonstrate changes in the bone trabecular pattern. They also allow diagnosis of bone collapse and sclerosis early in the disease where plain radiography is not as sensitive.

CT and Osteolysis – Since computed tomography scans show both the extent and the location of lytic lesions, they are useful to guide treatment decisions, as well as to assist in planning for surgical intervention when needed, in patients with suspected osteolysis after Total Hip Arthroplasty (THA).

CT and Tarsal Coalition – This is a congenital condition in which two or more bones in the mid-foot or hind-foot are joined. It usually presents during late childhood or late adolescence and is associated with repetitive ankle sprains. Mild pain, deep in the subtalar joint and limited range of motion are clinical symptoms. Tarsal coalition is detectable on oblique radiographs, but these are not routinely obtained at many institutions. Clinical diagnosis is not simple; it requires the expertise of skilled examiners. CT is valuable in diagnosing tarsal coalition because it allows differentiation of osseous from non-osseous coalitions and also depicts the extent of joint involvement as well as degenerative changes. It may also detect the overgrowth of the medial aspect of the talus that may be associated with talocalcaneal coalitions.

American Academy of Pediatrics “Choosing Wisely” Guidelines advise against ordering advanced imaging studies (MRI or CT) for most musculoskeletal conditions in a child until all appropriate clinical, laboratory and plain radiographic examinations have been completed. “History, physical examination, and appropriate radiographs remain the primary diagnostic modalities in pediatric orthopaedics, as they are both diagnostic and prognostic for the great majority of pediatric musculoskeletal conditions. Examples of such conditions would include, but not be limited to, the work up of injury or pain (spine, knees and ankles), possible infection, and deformity. MRI examinations and other advanced imaging studies frequently require

sedation in the young child (5 years old or less), and may not result in appropriate interpretation if clinical correlations cannot be made. Many conditions require specific MRI sequences or protocols best ordered by the specialist who will be treating the patient...if you believe findings warrant additional advanced imaging, discuss with the consulting orthopaedic surgeon to make sure the optimal studies are ordered.

POLICY HISTORY:

Review Date: May 2019

Review Summary:

- Reformatting in parallel with the new LE MRI. Updated references
- Added indication: peripheral nerve entrapment
- Criteria for approval of existing indications specified within the parameters of the current evidence base
- Added initial statement about approvals: ‘Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time’.
- Added Extremity mass indications including peripheral lymphadenopathy; and mass with increased risk for malignancy
- Modified Known Cancer indication to be more broad – ‘cancer staging, cancer restaging, signs or symptoms of recurrence’
- Expanded section for infection of bone or joint to include list of signs or symptoms and laboratory findings (elevated ESR or CRP, elevated white blood cell count, positive joint aspiration)

Review Date: May 2020

Review Summary:

- Expanded orthopedic signs listing and moved to the top
- Added note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging.
- Added labral tear/posterior impingement to approvable list
- Added flatfoot deformity
- Expanded section about initial work-up of a mass
- Added the National Comprehensive Care Network as a reference for imaging guidance
- Expanded the section on osteomyelitis
- Added section on crystalline arthropathy
- Revised the section on non or delayed union
- Added a section on loose bodies and synovial chondromatosis
- Added a pediatric section
- Removed Makoplasty from not approvable list
- Added a section about joint implants and hardware to the background section
- Updated references

REFERENCES:

American Academy of Pediatrics (AAP). Section on Orthopaedics and the Pediatric Orthopaedic Society of North America. Choosing Wisely®. <http://www.choosingwisely.org/clinician-lists/aap-posna-mri-or-ct-for-musculoskeletal-conditions-in-children/>. Released February 12, 2018.

Banerjee S, Cherian JJ, Elmallah RK, et al. Robotic-assisted knee arthroplasty. *Expert Rev Med Devices*. 2015; 12(6):727-735.

Beaman FD, Von Herrmann PF, Kransdorf MJ, et al. American College of Radiology ACR Appropriateness Criteria® - Suspected osteomyelitis, septic arthritis, or soft tissue infection (excluding spine and diabetic foot). *J Am Coll Radiol*. 2017; 14:S326-S337. <https://acsearch.acr.org/docs/3094201/Narrative/>.

Bencardino JT, Stone TJ, et al. ACR Appropriateness Criteria Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae. *J Am Coll Radiol*. 2017 May;14(5S):S293-S306.

~~Bencardino JT, Gyftopoulos S, Palmer WE. Imaging in anterior glenohumeral instability. *Radiology*. 2013 Nov; 269(2).~~

Bennett DL, Daffner RH, Weissman BN, et al. American College of Radiology ACR Appropriateness Criteria® - Non-traumatic Knee Pain. <https://acsearch.acr.org/docs/69432/Narrative/>. Published 2012.

Boas FE, Fleischman D. CT artifacts: Causes and reduction techniques. *Imaging Med*. 2012; 4(2): 229-240.

Bouchard M, Mosca VS. Flatfoot deformity in children and adolescents: surgical indications and management. *J Am Acad Orthop Surg*. 2014; 22(10):623.

Chou H, Chin TY, et al. Dual-energy CT in gout – A review of current concepts and applications. *J Med Radiat Sci*. 2017 Mar; 64(1): 41–51.

Colebatch AN, Edwards CJ, Østergaard M, et al. EULAR recommendations for the use of imaging of the joints in the clinical management of rheumatoid arthritis. *Ann Rheum Dis*. 2013; 72:804-814. <http://ard.bmj.com/content/72/6/804>.

Dodwell ER. Osteomyelitis and septic arthritis in children: Current concepts. *Curr Opin Pediatrics*. 2013 Feb; 5(1):58–63.

Domkundwar S, Autkar G, Khadilkar SV, et al. Ultrasound and EMG–NCV study (electromyography and nerve conduction velocity) correlation in diagnosis of nerve pathologies. *J Ultrasound*. 2017 Jun; 20(2):111-122.

Dommett RM, Redaniel MT, Stevens MC, et al. Features of cancer in teenagers and young adults in primary care: a population-based nested case-control study. *Br J Cancer*. 2013; 108(11):2329. Epub 2013 Apr 25.

Dong Q, Jacobsen JA, Jamadar DA, et al. Entrapment neuropathies in the upper and lower limbs: Anatomy and MRI features. *Radiol Res Practice*. 2012; 2012:230679.

Donovan A, Rosenberg ZS, Cavalcanti CF. MR imaging of entrapment neuropathies of the lower extremity. *Radiographics*. 2010; 30(4).

Doral MN, Bilge O, Huri G, et al. Modern treatment of meniscal tears. *EFORT Open Rev*. 2018; 3(5):260-268.

Dudhniwala AG, Rath NK, Joshy S, et al. Early failure with the Journey-Deuce bicompartamental knee arthroplasty. *Eur J Orthop Surg Traumatol*. 2016; 5:1-5.

Fayad LM, Carrino JA, Fishman EK. Musculoskeletal infection: Role of CT in the emergency department. *Radiographics*. 2007; 27:1723-36.

Felten R, Pemin P, Caillard S, et al. Avascular osteonecrosis in kidney transplant recipients: Risk factors in a recent cohort study and evaluation of the role of secondary hyperparathyroidism. *PLOS ONE*. February 22, 2019.

Fitzgerald JJ, Roberts CC, Daffner RH, et al. American College of Radiology ACR Appropriateness Criteria® - Follow-up of Malignant or Aggressive Musculoskeletal Tumors. <https://acsearch.acr.org/docs/69428/Narrative/>. Published 2015.

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. *Am J Roentgenol*. 2016; 207:142-149. 10.2214/AJR.15.14517.

Fritz J, Lurie B, Miller TT, et al. MR imaging of hip arthroplasty implants. *Radiographics*. 2014; 34(4):E106-E132. <http://pubs.rsna.org/doi/abs/10.1148/rg.344140010>.

Fritz J, Lurie B, Potter HG. MR imaging of knee arthroplasty implants. *Radiographics*. 2015 Aug; 35(5).

Gaddey HL, Riegel AM. Unexplained lymphadenopathy: Evaluation and differential diagnosis. *Am Fam Physician*. 2016 Dec 1; 94(11):896-903.

Garras DN, Raikin SM, Bhat SB, et al. MRI is Unnecessary for Diagnosing Acute Achilles Tendon Ruptures: Clinical Diagnostic Criteria. *Clin Orthop Relat Res*. 2012 Aug; 470(8): 2268–2273.

Gill SK, Smith J, Fox R, Chesser TJ. Investigation of occult hip fractures: the use of CT and MRI. *Sci World J*. 2013; 2013:830319.

Glaser C. Tarsal Coalitions: A Practical Approach to a Not-So-Rare Entity. *J Belgian Soc Radiol*. 2016; 100(1):104. DOI: <http://doi.org/10.5334/jbr-btr.1224>.

Glaudemans AWJM, Jutte PC, et al. Consensus document for the diagnosis of peripheral bone infection in adults: a joint paper by the EANM, EBJIS, and ESR (with ESCMID endorsement). *Eur J Nucl Med Mol Imaging*. 2019; 46(4): 957–970.

Groh MM, Herrera J. A comprehensive review of hip labral tears. *Curr Rev Musculoskelet Med*. 2009; 2(2):105-17.

[Guggenberger R, Pfirrmann CW, Koch PP, et al. Assessment of lower limb length and alignment by biplanar linear radiography: Comparison with supine CT and upright full-length radiography. *Am J Roentgenol*. 2014; 202\(2\):W161-W167.](#)

~~Guggenberger R, Pfirrmann CW, Koch PP, et al. Assessment of lower limb length and alignment by biplanar linear radiography: Comparison with supine CT and upright full-length radiography. *Am J Roentgenol*. 2014; 202(2): W161-W167.~~

Hananouchi T, Yasui Y, Yamamoto K, et al. Anterior impingement test for labral lesions has high positive predictive value. *Clin Orthop Relat Res*. 2012 Dec; 470(12):3524–3529.

Hesper T, Zilkens C, Bittersohl B, et al. Imaging modalities in patients with slipped capital femoral epiphysis. *J Child Orthop*. 2017; 11(2):99-106. <http://doi.org/10.1302/1863-2548-11-160276>. <https://www.ncbi.nlm.nih.gov/pubmed/28529656>.

Holzapfel K, Regler J, Baum T, et. al. Local Staging of Soft-Tissue Sarcoma: Emphasis on Assessment of Neurovascular Encasement—Value of MR Imaging in 174 Confirmed Cases. *Radiology*. 2015 Jan; 275(2).

[Hussin P, Mawardi M, et al. The 'Chalky Culprit' of acute locked knee. *G Chir*. 2014; 35\(9-10\):239–240.](#)

Iyer RS, Chapman T, et al. Pediatric bone imaging: Diagnostic imaging of osteoid osteoma. *Am J Roentgenol*. 2012; 198:1039-1052.

Johnson AJ, Costa CR, Mont MA. Do we need gender-specific total joint arthroplasty? *Clin Orthop Relat Res*. 2011; 469(7):1852-1858.

[Kellar J, Givertz A, et al. Biphosphonate-related Femoral Shaft Fracture. *Clin Pract Cases Emerg Med*. 2020 Feb; 4\(1\):62-64.](#)

Khan AN, Seriki DM, Hutchinson E, et al. Legg-Calve-Perthes Disease. *Emedicine*. 2011. <http://emedicine.medscape.com/article/410482-overview>.

Kamegaya M, Saisu T, Nakamura J, et al. Drehmann sign and femoro-acetabular impingement in SCFE. *J Ped Orthop*. 2011 Dec; 31(8):853-857.

Katz JN, Brophy RH, Chaisson CE, et al. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *N Engl J Med*. 2013; 368:1675-1684.

~~Kijowski R, Choi J, Shinki K, et al. Validation of MRI classification system for tibial stress injuries. *Am J Roentgenol*. 2012; 198:878-884.~~

Kircher MF, Willman JK. Molecular body imaging: MR imaging, CT, and US. Part II. Applications. *Radiology*. 2012; 264(2):349.

Laya BF, Restrepo R, Lee EY. Practical imaging evaluation of foreign bodies in children: An update. *Radiol Clin North Am*. 2017 Jul; 55(4):845-867.

Lefevre N, Naouri JF, Herman S, et al. A current review of the meniscus imaging: Proposition of a useful tool for its radiologic analysis. *Radiol Res Pract*. 2016; 2016:8329296.

Mandell JC, Khurana B, Smith JT, et al. Osteomyelitis of the lower extremity: Pathophysiology, imaging, and classification, with an emphasis on diabetic foot infection. *Emerg Radiol*. 2017.

Mintz DN, Roberts CC, et al. ACR Appropriateness Criteria Chronic Hip Pain. *J Am Coll Radiol*. 2017 May; 14(5S):S90-S102.

Mohankumar R, White L, Naraghi A. Review. Pitfalls and pearls in MRI of the knee. *AJR Am J Roentgenol*. 2014; 203:516-530. <https://www.ajronline.org/doi/full/10.2214/AJR.14.12969>.

Mohseni S, Shojaiefard A, Khorgami Z, et al. Peripheral lymphadenopathy: Approach and diagnostic tools. *Iran J Med Sci*. 2014 Mar; 39(2 Suppl):158-170.

Mordecai SC, Al-Hadithy N, Ware HE, et al. Treatment of meniscal tears: An evidence based approach. *World J Orthop*. 2014 Jul 18; 5(3):233-241.

Morrison WB, Weissman BN, Kransdorf MJ, et al. American College of Radiology ACR Appropriateness Criteria® - Primary Bone Tumors. <https://acsearch.acr.org/docs/69421/Narrative/>. Published 2013.

Morshed S. Current Options for Determining Fracture Union. *Adv Med*. 2014; 2014:708574.

Mullan CP, Madan R, Trotman-Dickenson B, et al. Radiology of chest wall masses. *AJR*. 2011; 2011:197(3).

Murphey MD, Foreman KL, Klassen Fischer MK, et al. From the radiologic pathology archives imaging of osteonecrosis: Radiologic-pathologic correlation. *RadioGraphics*. 2014 Jul 14; 34(4).

Murphey MD, Roberts CC, Bencardino JT, et al. American College of Radiology ACR Appropriateness Criteria® - Osteonecrosis of the Hip. *J Am Coll Radiol*. 2016; 13:147-155. <https://acsearch.acr.org/docs/69420/Narrative/>.

Murphey MD, Wessell DE, et al. ACR Appropriateness Criteria Soft-Tissue Masses. *J Am Coll Radiol*. 2018 May; 15(Suppl 5):S189-S197.

Nair RG, Tripathy G, and Deysine GR. Computer navigation systems in unicompartmental knee arthroplasty: A systematic review. *Am J Orthop*. 2014; 43(6):256-261.

Naraghi A, White LM. MRI of labral and chondral lesions of the hip. *AJR Am J Roentgenol*. 2015; 205(3):479-490. <https://www.ajronline.org/doi/full/10.2214/AJR.14.12581>.

National Comprehensive Cancer Network (NCCN). Imaging guidelines. 2019. https://www.nccn.org/professionals/physician_gls/default.aspx.

Patel DS, Roth M, Kapil N. Stress fractures: diagnosis, treatment, and prevention. *Am Fam Physician*. 2011; 83:39-46. <https://www.ncbi.nlm.nih.gov/pubmed/21888126>.

Peck DM, Voss LM, Voss TT. Slipped capital femoral epiphysis: Diagnosis and management. *Am Fam Physician*. 2017 Jun 15; 95(12):779-784.

Peck J, Gustafson KE, Bahner DP. Diagnosis of achilles tendon rupture with ultrasound in the emergency department setting. *Int J Academ Med*. 2017; 3(3):205-207.

Rabinovich RV, Haleem AM, Rozbruch SR. Complex ankle arthrodesis: Review of the literature. *World J Orthop*. 2015 Sep 18; 6(8):602–613.

Ross AB, Lee KS, et al. ACR Appropriateness Criteria Acute Hip Pain-Suspected Fracture. *J Am Coll Radiol*. 2019 May; 16(5S):S18-S25.

Sabharwal S, Kumar A. Methods for Assessing Leg Length Discrepancy. *Clin Orthop Relat Res*. 2008 Dec; 466(12):2910–2922.

Sadineni RT, Psumarthy A, Bellapa NC, et al. Imaging patterns in MRI in recent bone injuries following negative or inconclusive plain radiographs. *J Clin Diagn Res*. 2015 Oct; 9(10):TC10–TC13.

Salih S, Blakey C, Chan D, et al. The callus fracture sign: a radiological predictor of progression to hypertrophic non-union in diaphyseal tibial fractures. *Strat Trauma Limb Reconstr.* 2015; 10(3):149–153.

Scalcione LR, Gimber LH, Ho AM, et al. Spectrum of carpal dislocations and fracture-dislocations: Imaging and management. *Am J Roentgenol.* 2014; 203:541-550.

Sinha S, Peach AH. Diagnosis and management of soft tissue sarcoma. *BMJ.* 2010; 341:c7170.

Slaughter AJ, Reynolds KA, Jambhekar K, et al. Clinical orthopedic examination findings in the lower extremity: Correlation with imaging studies and diagnostic efficacy. *Radiographics.* 2014 Mar; 34(2).

Smith TO, Drew BT, Toms AP, et al. Accuracy of magnetic resonance imaging, magnetic resonance arthrography and computed tomography for the detection of chondral lesions of the knee. *Knee Surg Sports Traumatol Arthrosc.* 2012 Dec; 20(12):2367-79. Epub 2012 Jan 24.

Smith BE, Thacker D, Crewesmith A, Hall M. Special tests for assessing meniscal tears within the knee: A systematic review and meta-analysis. *Evid Based Med.* 2015; 20:88-97.

Subhawong TK, Fishman EK, Swart JE, et al. Soft-tissue masses and masslike conditions: What does CT add to diagnosis and management? *AJR Am J Roentgenol.* 2010 Jun; 194(6):1559–1567.

Thorpe SW, Wukich DK. Tarsal coalitions in the adult population: Does treatment differ from the adolescent? *Foot Ankle Clin.* 2012 Jun; 17(2):195-204.

Tos P, Crosio A, Pugliese P, et. el. Painful scar neuropathy: Principles of diagnosis and treatment. *Plast Aesthet Res.* 2015; 2:156-64.

Tuite MJ, Daffner RH, Weissman BN, et al. American College of Radiology Appropriateness Criteria® - Acute Trauma to the Knee. 2014. <https://acsearch.acr.org/docs/69419/Narrative/>.

Turan A, Celtikci P, Tufan A, et al. Basic radiological assessment of synovial diseases: A pictorial essay. *Eur J Rheumatol.* 2017 Jun; 4(2):166-74.

Van Bergen CJA, Van den Ende KIM, Ten Brinke B, et al. Osteochondritis dissecans of the capitellum in adolescents. *World J Orthop.* 2016 Feb 18; 7(2):102–108.

Van Dijk CN, Reilingh ML, Zengerink M, et al. Osteochondral defects in the ankle: Why painful? *Knee Surg Sports Traumatol Arthrosc.* 2010 May; 18(5):570–580.

Vuurberg G, Hoorntje A, Wink LM, et.al. Diagnosis, treatment, and prevention of ankle sprains: Update of an evidence-based clinical guideline. *Br J Sports Med.* 2018; 52(15):956. Epub 2018 Mar 7.

Wali Y, Almaskan S. Avascular necrosis of the hip in sickle cell disease in oman. Is it serious enough to warrant bone marrow transplantation? *Sultan Qaboos Univ Med J*. 2011 Feb; 11(1):127–128.

Walker EA, Beaman FD, et al. ACR Appropriateness Criteria Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus. *J Am Coll Radiol*. 2019 Nov; 16(Suppl 11):S440-S450.

Ward RJ, Weissman BN, Kransdorf MJ, et al. American College of Radiology ACR Appropriateness Criteria® - Acute Hip Pain–Suspected Fracture. 2013.
<https://acsearch.acr.org/docs/3082587/Narrative/>.

Wilkins R, Bisson LJ. Operative versus nonoperative management of acute achilles tendon ruptures: A quantitative systematic review of randomized controlled trials. *Am J Sports Med*. 2012; 40(9):2154. Epub 2012 Jul 16.

Zoga AC, Weissman BN, Kransdorf MJ, et al. American College of Radiology ACR Appropriateness Criteria® – Soft Tissue Masses. 2017.
<https://acsearch.acr.org/docs/69434/Narrative/>.

Zollars ES, Hyer M, Wolf B, et al. Measuring lupus arthritis activity using contrasted high-field MRI. Associations with clinical measures of disease activity and novel patterns of disease Lupus. *Science Med*. 2018; 5:e000264. doi: 10.1136/lupus-2018-000264.

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