American College of Radiology
ACR Appropriateness Criteria®

Acutely Limping Child Up To Age 5

Variant: 1 Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography tibia and fibula	Usually Appropriate	☢
Radiography femur	May Be Appropriate	☢☢
Radiography foot	May Be Appropriate (Disagreement)	☢
US hips	Usually Not Appropriate	O
US lower extremity	Usually Not Appropriate	O
Radiography pelvis	Usually Not Appropriate	☢☢
Radiography lumbar spine	Usually Not Appropriate	☢☢
3-phase bone scan pelvis and lower extremity	Usually Not Appropriate	☢☢☢☢
MRI lower extremity without and with IV contrast	Usually Not Appropriate	O
MRI lower extremity without IV contrast	Usually Not Appropriate	O
MRI whole body without and with IV contrast	Usually Not Appropriate	O
MRI whole body without IV contrast	Usually Not Appropriate	O
CT lower extremity with IV contrast	Usually Not Appropriate	☢☢☢☢
CT lower extremity without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT lower extremity without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography lower extremity area of interest	Usually Appropriate	☢☢
US hips	Usually Not Appropriate	O
US lower extremity area of interest (not pelvis or hip)	Usually Not Appropriate	O
3-phase bone scan pelvis and lower extremity	Usually Not Appropriate	☢☢☢☢
MRI lower extremity area of interest without and with IV contrast	Usually Not Appropriate	O
MRI lower extremity area of interest without IV contrast	Usually Not Appropriate	O
CT lower extremity area of interest with IV contrast	Usually Not Appropriate	Varies
CT lower extremity area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT lower extremity area of interest without IV contrast	Usually Not Appropriate	Varies

Variant: 3 Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
MRI lower extremity without and with IV contrast	Usually Appropriate	O
MRI lower extremity without IV contrast	Usually Appropriate	O
US hips	May Be Appropriate	O
3-phase bone scan pelvis and lower extremity	May Be Appropriate	☢☢☢☢
MRI whole body without and with IV contrast	May Be Appropriate	O

MRI whole body without IV contrast	May Be Appropriate	O
US lower extremity	Usually Not Appropriate	O
Radiography femur	Usually Not Appropriate	☢☢
Radiography foot	Usually Not Appropriate	☢
Radiography tibia and fibula	Usually Not Appropriate	☢
Radiography pelvis	Usually Not Appropriate	☢☢
Radiography lumbar spine	Usually Not Appropriate	☢☢
CT lower extremity with IV contrast	Usually Not Appropriate	☢☢☢☢
CT lower extremity without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT lower extremity without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 4 Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US hips	Usually Appropriate	O
MRI pelvis without and with IV contrast	Usually Appropriate	O
MRI pelvis without IV contrast	Usually Appropriate	O
Radiography pelvis	May Be Appropriate	☢☢
3-phase bone scan pelvis and lower extremity	May Be Appropriate	☢☢☢☢
Radiography lumbar spine	Usually Not Appropriate	☢☢
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 5 Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
MRI lower extremity area of interest (not pelvis or hip) without IV contrast	Usually Appropriate	O
MRI lower extremity area of interest (not pelvis or hip) without and with IV contrast	Usually Appropriate	O
US lower extremity area of interest (not pelvis or hip)	May Be Appropriate	O
Radiography lower extremity area of interest (not pelvis or hip)	May Be Appropriate	☢☢
3-phase bone scan pelvis and lower extremity	Usually Not Appropriate	☢☢☢☢
MRI whole body without and with IV contrast	Usually Not Appropriate	O
MRI whole body without IV contrast	Usually Not Appropriate	O
CT lower extremity area of interest (not pelvis or hip) without IV contrast	Usually Not Appropriate	Varies
CT lower extremity area of interest (not pelvis or hip) with IV contrast	Usually Not Appropriate	Varies
CT lower extremity area of interest (not pelvis or hip) without and with IV contrast	Usually Not Appropriate	Varies

Panel Members

Nabile M. Safdar, MD, MPH[a], Cynthia K. Rigsby, MD[b], Ramesh S. Iyer, MD[c], Adina L. Alazraki, MD[d], Sudha A. Anupindi, MD[e], Dianna M. E. Bardo, MD[f], Brandon P. Brown, MD[g], Sherwin S. Chan, MD,

PhD[h], Tushar Chandra, MD[i], Jonathan R. Dillman, MD, MSc[j], Scott R. Dorfman, MD[k], Matthew D. Garber, MD[l], H.F. Samuel Lam, MD, MPH[m], Jie C. Nguyen, MD, MS[n], Alan Siegel, MD, MS[o], Roger F. Widmann, MD[p], Boaz Karmazyn, MD[q]

Summary of Literature Review

Introduction/Background

Acute onset of limp or refusal to walk is a common complaint in children, accounting for approximately 4% of visits in one pediatric emergency department [1]. The acutely limping child can be a diagnostic dilemma for clinicians. Most commonly, the acute limp is caused by minor trauma or self-limiting benign conditions but can also be caused by limb-threatening or life-threatening etiologies [2-6]. The cause of limp can usually be determined by a careful history and physical examination. The differential diagnosis of limping is broad and depends on the presence of signs of infection, localization of pain, and history of trauma [6]. The differential diagnosis in a limping child also depends on age. This discussion relates to the initial imaging of the ambulatory child under the age of 5 years who presents with an acute onset of a limp.

The presence of fever, elevated white blood cell count, elevated erythrocyte sedimentation rate, or elevated C-reactive protein suggests infection. Localization of pathology is based on site of pain, tenderness, presence of erythema, swelling, and positive physical maneuvers and signs, such as the Trendelenburg test, Galeazzi sign, Patrick/FABER test, pelvic compression test, and psoas sign [7]. A detailed analysis of gait can suggest the diagnosis [6].

The decision-making process about initial imaging must take into account the level of suspicion for infection and whether symptoms can be localized specifically. Localizing symptoms enables a focused examination. When symptoms cannot be localized, imaging approaches that can cover wider anatomic areas may have more diagnostic value. In this document, when symptoms cannot be localized, "lower extremity" imaging includes the hips through the feet.

Discussion of Procedures by Variant

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.

The most common noninfectious etiology of acute limping in children is a minor traumatic injury [8]. Unfortunately, particularly in younger children, it is common that the pain cannot be accurately localized to one focal area. When there is no concern for infection and pain cannot be localized through history or physical examination, an imaging strategy designed to first localize the source of the pain and subsequently better characterize the cause is typically pursued.

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.

A. Radiography Lower Extremities

In children <4 years of age, it is common for clinicians to order radiographs from the pelvis through the feet because of the patients' typical lack of verbalization and inability to localize symptoms [9]. Radiographs of the lower extremities are often normal [10,11], with reports of fracture incidence ranging from 4% to 20% [12]. Spiral tibial fractures are by far the most common fractures found in children <4 years of age presenting with nonlocalized limp or refusal to bear

weight. Other fractures in the ankle and foot are also described [12]. Therefore, in the walking child, initial evaluation with limited tibial/fibula radiographs was suggested rather than total extremity (pelvis, femur, tibia/fibula, and/or ankle/foot) radiographs [13].

If initial imaging is normal but symptoms persist, follow-up radiographs or radiographs of areas besides the tibia/fibula may be useful. In the Baron et al study [13], approximately 10% of tibial fractures were only visible on follow-up radiographs and not initial imaging. One patient, who was discharged, later returned with worsening symptoms and signs of infection and was found to have spinal discitis and epidural abscess. As these examples illustrate, if the initial evaluation is negative and symptoms persist or worsen, a follow-up clinical reassessment and further imaging evaluation may be necessary.

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.
B. US Hips or Lower Extremity

There is no relevant literature regarding the use of ultrasound (US) in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.

US is sensitive in evaluation of joint effusions and soft-tissue fluid collections; however, the typical field of view is small, limiting the role of US when symptoms and clinical evaluation cannot localize the site of pathology [14]. Because pain that is due to hip pathology can be referred elsewhere in the lower extremity, such as the thigh, knee, or buttock [15], US of the hip could be considered if initial radiographs are negative and symptoms persist.

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.
C. 3-Phase Bone Scan Pelvis and Lower Extremity

There is no relevant literature regarding the use of bone scan in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.

Scintigraphic bone scan is sensitive in detecting bone pathology and could have a role in localizing the pathology in limping children when the examination is nonfocal, radiographs are negative, and symptoms persist [1,10,16,17]. However, a bone scan lacks specificity in this clinical scenario [1,10,16].

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.
D. CT Lower Extremity

There is no relevant literature regarding the use of CT in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.

CT without intravenous (IV) contrast can be useful in a few selected cases for preoperative planning after radiographs demonstrate a complex fracture [18].

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.
E. MRI Lower Extremity

There is no relevant literature regarding the use of MRI pelvis/hips to feet in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.

MRI is sensitive and specific for soft-tissue, cartilage, and bony pathology, including detection of stress reaction/fractures [19]. It may be performed in selected children when radiographs, clinical and imaging follow-up, and thorough physical examination fail to provide diagnostic clues about the source of symptoms.

Variant 1: Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.
F. MRI Whole-Body

There is no relevant literature regarding the use of whole-body MRI in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.

Because whole-body MRI is sensitive and specific for soft-tissue, joint, and bony pathology, and it allows for coverage of all musculoskeletal anatomy, it could play a role in localizing pathology in the limping child when the examination is nonfocal, the initial imaging workup is negative, and symptoms persist. Whole-body MRI has been shown to have more superior sensitivity than scintigraphic bone scans or radiography in detection of multifocal neoplastic lesions and chronic nonbacterial osteomyelitis/chronic recurrent multifocal osteomyelitis [20-22]. Whole-body MRI may be sensitive for detecting sites of involvement with inflammatory arthritides or osteonecrosis [23-25].

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.

The body regions covered in this clinical scenario are: hip, femur, knee, tibia/fibula, ankle, and foot.

Localized pain may be due to trauma, in which case it is important to exclude an underlying fracture. Clinical examination and history may allow localization of the pain or injury to a specific area, which allows a more focused imaging evaluation [26].

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.
A. Radiography Lower Extremity

Targeted radiographs of the areas of concern have a role in evaluating for possible fracture [12,26-29]. Negative radiographs do not completely exclude the possibility of a nondisplaced fracture. Dunbar et al [30] first described the term "toddler's fracture" in 1963 as a nondisplaced oblique distal tibial fracture that may often go unrecognized. Halsey et al [27] reported that in 39 children with a presumptive diagnosis of toddler's fracture by clinical criteria and a negative initial radiographic workup, 16 (41%) had radiographic evidence of toddler's fracture on follow-up radiographs. Other studies have found that radiographs are not always sensitive to the presence of toddler's fracture [28,29].

Other causes of limp or pain, such as osteochondritis, apophysitis, osteonecrosis, or tumor, may be diagnosed with radiographs, though MRI has better sensitivity for such pathologies [31,32].

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.
B. US Hips or Lower Extremity

US has a limited field of view and has lower accuracy in detection of fractures as compared with radiographs. Weinberg et al

[33] showed that clinician-performed US had a sensitivity and specificity of 73% and 92%, respectively, for the evaluation of fractures in children and young adults, with radiography or CT as the reference standard.

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.
C. 3-Phase Bone Scan Pelvis and Lower Extremity

There is no relevant literature regarding the use of bone scan in the initial evaluation of acute limp with localized symptoms and no concern for infection.

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.
D. CT Lower Extremity

There is no relevant literature regarding the use of CT in the initial evaluation of acute limp with localized symptoms and no concern for infection.

CT without IV contrast can be useful in a few selected cases for preoperative planning after radiographs demonstrate a complex or intra-articular fracture [18].

Variant 2: Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.
E. MRI Lower Extremity

There is no relevant literature regarding the use of MRI in the initial evaluation of acute limp with localized symptoms and no concern for infection.

In children with persistent limp and negative radiographs, MRI is highly sensitive in detection of stress reaction/fractures [6]. When there are clinical signs of nonseptic arthritis, MRI is superior to both US and radiography in detecting inflammatory changes, early erosions, and cartilage thinning [34-37]. MRI should be performed when a tumor is suspected as it is sensitive for evaluation of bone marrow and soft-tissue extension [38].

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.

Limping in the presence of one or more of the following clinical and laboratory signs should suggest the possibility of infection: fever, elevated white blood cell count, elevated erythrocyte sedimentation rate, or *elevated* C-reactive protein. The differential diagnoses in this scenario most commonly include septic arthritis, osteomyelitis, discitis, pyomyositis, Langerhans cell histiocytosis, and tumor (eg, leukemia, osteosarcoma, Ewing sarcoma, and metastatic disease).

When there are signs and symptoms suggestive of an infectious process, imaging has a role in substantiating the diagnosis, localizing the site of infection, evaluating for complications that require surgical intervention, and excluding other pathologies that mimic infection.

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.
A. Radiography Lower Extremities

Radiographs have low yield in detecting infection when symptoms and signs are not localized [39,40].

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection.

Initial imaging.
B. US Hips or Lower Extremity

A small field of view limits the role of US when symptoms and clinical evaluation cannot localize the site of pathology [14]. Because pain that is due to hip pathology can be referred elsewhere in the lower extremity, such as the thigh, knee, or buttock [15], US of the hip could be considered even when symptoms cannot be well localized.

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.
C. 3-Phase Bone Scan Pelvis and Lower Extremity

Bone scan is reported to have a high sensitivity for the diagnosis of osteomyelitis [17]. Advantages of bone scan in the evaluation of infection include whole-body imaging for site localization, with the main disadvantage being the lack of soft-tissue evaluation and anatomic detail, particularly for the detection of small abscesses [16]. Bone scan may be particularly helpful in cases with implanted hardware and postoperative patients already with extensive edema and tissue alternations. A few case series suggest that bone scan has a lower sensitivity in the detection of source of infection relative to MRI [39-41].

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.
D. MRI Lower Extremity

MRI, given its sensitivity to soft-tissue and bone marrow pathology, has high accuracy in diagnosing infection, including septic arthritis, osteomyelitis, pyomyositis, and discitis [42,43], and could be considered as the initial imaging study [44]. Large field-of-view coronal T1-weighted and fluid-sensitive sequences covering from the pelvis and hips to the ankles may be performed to identify any abnormality. Inclusion of the lower thoracic spine and lumbar spine should be considered if lower extremity or hip pathology is not found and symptoms persist, as some patients with discitis may not have localized symptoms to the back [45-48]. Once localized, additional MRI sequences with smaller fields of view can be performed for further characterization [49]. Contrast administration in the MRI evaluation of suspected soft-tissue or osseous infection does not increase sensitivity or specificity but may increase reader confidence and better delineate abscesses [50,51]. Contrast administration during MRI should be considered in specific cases to improve detection of an abscess when there is significant soft-tissue edema [50,51]. An exception to this may be infants, in whom infection of the epiphyses can be occult on unenhanced MRI sequences [52]. Given these considerations, the use of IV contrast may vary with institutional protocol.

While no prospective study of MRI versus bone scan has been performed, there are retrospective studies suggesting superiority of MRI over bone scan in detecting the source of infection, with sensitivity of 99% to 100% for MRI compared to 53% to 71% for bone scan [39,40]. Because of low bone scan sensitivity for soft-tissue pathology, MRI is often obtained after a positive bone scan for further evaluation of soft-tissues, primarily to detect abscess formation that requires drainage [41].

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.
E. MRI Whole-Body

MRI, given its sensitivity to soft-tissue and bone marrow pathology, has high accuracy in diagnosing infection, including septic arthritis, osteomyelitis, pyomyositis, and discitis [42,43]. Like

bone scan, whole-body MRI provides a total-body screen and is sensitive in detecting osseous abnormalities. As such, whole-body MRI may be an appropriate choice when there is suspicion for multifocal osteomyelitis [22,53,54]. While there is no single protocol for whole-body MRI, sequences may include the use of fluid-sensitive, T1-weighted, diffusion-weighted imaging, or chemical shift imaging, with or without the use of IV contrast [53,55].

Variant 3: Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.
F. CT Lower Extremity

There is no relevant literature regarding the use of CT in the initial evaluation of acute limp with nonlocalized symptoms and concern for infection.

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.

If pain or physical examination appears localized to the hip, the diagnosis is septic arthritis until proven otherwise. Septic arthritis is the most common cause of acute severe monoarticular pain in children. It typically results from hematogenous and subsequent intra-articular spread of *Staphylococcus aureus*, with the hip being the most common site of involvement. In some cases, septic arthritis of the hip may be secondary to adjacent osteomyelitis [56]. Septic arthritis requires rapid diagnosis and intervention to prevent permanent damage to the joint [57]. In children with signs of infection and absence of a hip effusion, a diagnosis of pelvic osteomyelitis or pyomyositis should be considered [40].

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.
A. Radiography Pelvis or Lumbar Spine

There are limited data to support the use of radiographs in the initial evaluation of possible septic hip. The sensitivity and specificity of radiographs for the diagnosis of septic hip are low [58].

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.
B. US Hips

US of the hip allows quick and accurate diagnosis of a joint effusion and can be used to guide aspiration [59,60]. Various investigators have had differing results in differentiating septic arthritis from transient synovitis of the hip when using US in combination with laboratory and clinical data [57,61]. A false-negative US is uncommon and could occur when sonography is performed within 24 hours of onset of symptoms [62]. It is important to be aware that there may be other etiologies to a hip effusion, including fractures, osteonecrosis, and juvenile idiopathic arthritis.

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.
C. 3-Phase Bone Scan Pelvis and Lower Extremity

Bone scan was found to have only 70% sensitivity, as compared to MRI, in a series of 33 patients in detecting source of infection in children presented with acute hip pain who did not have septic hip [40].

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.
D. CT Pelvis

CT has decreased sensitivity in the detection of bone marrow pathology and decreased soft-tissue contrast compared to MRI [63-65]. CT with IV contrast could be considered in children with contraindications to MRI [66].

Variant 4: Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.
E. MRI Pelvis

MRI has high sensitivity and specificity for musculoskeletal infection, such as septic arthritis, osteomyelitis, and pyomyositis [67]. MRI detected osteomyelitis in about half of children with clinically suspected septic arthritis [56], and septic arthritis was found to be associated with osteomyelitis in MRI in about 70% of patients. Some also have soft-tissue abscesses [67]. For this reason, some advocate using MRI in the initial evaluation of suspected septic arthritis of the hips.

In children with signs of infection and acute hip pain with no evidence of septic arthritis, MRI was shown to have better sensitivity than bone scan in detection of the source of infection [40,41]. In addition, osteomyelitis of the pelvis is commonly (28%) associated with soft-tissue abscesses [68], which are easily detected by MRI. Some advocate performing MRI of the pelvis even in children with known septic arthritis because of the possibility of associated osteomyelitis and soft-tissue abscess [69].

Findings of hip effusion associated with bone marrow edema or decreased enhancement of the femoral head should raise the possibility of septic arthritis [70,71]; although, definite diagnosis of septic arthritis requires joint aspiration and fluid analysis.

Contrast administration in the MRI evaluation of suspected soft-tissue or osseous infection does not increase sensitivity or specificity but increases reader confidence and better delineates abscesses [50,51]. An exception to this may be in infants and younger children with an abundance of nonossified cartilage, in whom infection limited to the intrinsically hyperintense cartilaginous growth plate and epiphyses/apophyses can be occult on unenhanced MRI sequences. Given these considerations, the use of IV contrast may vary with institutional protocol.

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.

The body regions covered in this clinical scenario are: femur, knee, tibia/fibula, ankle, and foot.

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
A. Radiography Lower Extremity

There are limited evidence to support the use of radiographs for the acute evaluation of localized infection. The sensitivity of radiographs in detecting early osteomyelitis or soft-tissue infection is low [39,40]. While soft-tissue signs of swelling and edema may be detected early by radiographs and nonspecific signs, such as periosteal reaction and osteopenia, detection of bone destruction may take up to 3 weeks after onset of symptoms [54,64,72].

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
B. US Lower Extremity

US may play a role in diagnosing pyomyositis, in which inflammatory change may lead to an altered sonographic appearance in affected muscle

[73,74]. Because US will not penetrate cortex, it is unable to evaluate bone marrow and is not sensitive for osteomyelitis. US is sensitive to subperiosteal collections, which can be seen with osteomyelitis [54,75].

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
C. 3-Phase Bone Scan Pelvis and Lower Extremity

Bone scan has been reported to have a high sensitivity for the diagnosis of osteomyelitis, albeit with lower reported specificity. However, its utility is greatest when symptoms cannot be localized. The main limitation of bone scan with a localized examination is in the detection of soft-tissue abscess [39,41].

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
D. CT Lower Extremity

CT has decreased sensitivity in the detection of bone marrow pathology and decreased soft-tissue contrast compared to MRI [63-65]. CT with IV contrast can be considered when soft-tissue infection is of concern or in children with contraindications to MRI [66].

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
E. MRI Lower Extremity

MRI, given its sensitivity to musculoskeletal injury and inflammation, has high accuracy in diagnosing infection, specifically osteomyelitis and pyomyositis [43,76]. Contrast administration improves detection of soft-tissue abscesses in selected patients with soft-tissue edema [50,51]. Because of low bone scan sensitivity for soft-tissue pathology, MRI may sometimes need to be obtained after a positive bone scan for further evaluation of soft-tissues pathology mainly to detect any abscess formation that requires drainage [41].

Contrast administration in the MRI evaluation of suspected soft-tissue or osseous infection does not increase sensitivity or specificity but may increase reader confidence and better delineate abscesses [50,51]. Contrast administration during MRI should be considered in specific cases to improve detection of small abscesses when there is significant soft-tissue edema [50,51]. The need for sedation in young patients undergoing MRI is a consideration.

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
F. MRI Whole-Body

There is no relevant literature regarding the use of whole-body MRI in the initial evaluation of acute limp with localized symptoms to the lower extremity and concern for infection.

Whole-body MRI may be very sensitive for osteomyelitis. However, its greatest utility is when multifocal osteomyelitis is suspected or symptoms cannot be localized [22,53,54].

Variant 5: Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.
G. Other Diagnoses

Since acute limping and hip pain in children can have many etiologies, the causes are covered in more than one of the appropriateness criteria documents. As such, symptoms localized to the back

are covered in the ACR Appropriateness Criteria® topic on "Back Pain–Child" [77].

Summary of Highlights

- **Variant 1:** A radiograph of the tibia/fibula is usually appropriate for the initial imaging of children up to age 5 with acute limp, nonlocalized symptoms, and no concern for infection.
- **Variant 2:** Radiographs of the lower extremity area of interest are usually appropriate for the initial imaging of children up to age 5 with acute limp, pain, localized symptoms, and no concern for infection.
- **Variant 3:** MRI of the lower extremity without and with IV contrast or MRI lower extremity without IV contrast is usually appropriate for the initial imaging of children up to age 5 with acute limp, nonlocalized symptoms, and concern for infection. These procedures are equivalent alternatives.
- **Variant 4:** US hips and MRI pelvis without and with IV contrast or MRI pelvis without IV contrast are usually appropriate for the initial imaging of children up to age 5 with acute limp, symptoms localized to the hip, and concern for infection. These procedures are complementary (ie, more than one can be performed).
- **Variant 5:** MRI lower extremity area of interest (not pelvis or hip) without and with IV contrast or MRI lower extremity area of interest (not pelvis or hip) without IV contrast is usually appropriate for the initial imaging of children up to age 5 with acute limp, symptoms localized to lower extremity (not pelvis or hips), and concern for infection. These procedures are equivalent alternatives.

Summary of Evidence

Of the 78 references cited in the *ACR Appropriateness Criteria® Acutely Limping Child Up To Age 5* document, 77 references are categorized as diagnostic references including 7 good-quality studies, and 11 quality studies that may have design limitations. There are 59 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

The 78 references cited in the ACR Appropriateness Criteria® *Acutely Limping Child Up To Age 5* document were published from 1964 to 2017.

Although there are references that report on studies with design limitations, 7 good-quality studies provide good evidence.

Supporting Documents

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

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

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

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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

[a]Emory University, Atlanta, Georgia. [b]Panel Chair, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois. [c]Panel Vice-Chair, Seattle Children's Hospital, Seattle, Washington. [d]Children's Healthcare of Atlanta, Atlanta, Georgia. [e]Children's Hospital of Philadelphia,

Philadelphia, Pennsylvania. [f]Phoenix Children's Hospital, Phoenix, Arizona. [g]Riley Hospital for Children Indiana University, Indianapolis, Indiana. [h]Children's Mercy Hospital, Kansas City, Missouri. [i]Nemours Children's Hospital, Orlando, Florida. [j]Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio. [k]Texas Children's Hospital, Houston, Texas. [l]Wolfson Children's Hospital, Jacksonville, Florida; American Academy of Pediatrics. [m]Sutter Medical Center Sacramento, Sacramento, California; American College of Emergency Physicians. [n]Children's Hospital of Philadelphia, Philadelphia, Pennsylvania. [o]Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire. [p]Hospital for Special Surgery, New York, New York; American Academy of Orthopaedic Surgeons. [q]Specialty Chair, Riley Hospital for Children Indiana University, Indianapolis, Indiana.