

American College of Radiology ACR Appropriateness Criteria®

Clinical Condition: Limping Child—Ages 0-5 Years

Variant 1: Nonfocal clinical exam.

Radiologic Procedure	Rating	Comments	RRL*
X-ray pelvis and lower extremity	8	Pelvis, femur (including knee), lower leg and foot are all imaged.	Low
NUC Tc-99m 3-phase bone scan lower extremity	6	Follow-up study when limping persists and radiographs negative.	Med
MRI pelvis and lower extremity	6	Follow-up study as needed. See comments regarding contrast in text under “Anticipated Exceptions.”	None
US hip	5	Follow-up study as needed.	None
X-ray spine	3		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: Focal clinical exam (not septic arthritis).

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	Consider imaging region above and below area of concern.	NS
NUC Tc-99m 3-phase bone scan lower extremity	7	Follow-up study as needed.	Med
MRI area of interest	7	Follow-up study as needed. Use contrast as clinically indicated. See comments regarding contrast in text under “Anticipated Exceptions.”	None
US area of interest	3		None
CT area of interest	2		NS
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 3: Suspected septic arthritis.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9		NS
US area of interest	8	Most useful at hip.	None
NUC Tc-99m 3-phase bone scan lower extremity	7	Follow-up study as needed.	Med
MRI area of interest	7	Follow-up study as needed. See comments regarding contrast in text under “Anticipated Exceptions.”	None
CT area of interest	2		NS
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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LIMPING CHILD—AGES 0-5 YEARS

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Summary of Literature Review

Limping is a common clinical problem in childhood, and it can be a diagnostic dilemma [1-10]. Limping is a specific type of gait abnormality due to pain. Typically, one must consider processes from the spine to the toes as potential causes of a limp, which makes the list of possibilities quite long [11]. Children frequently are unable to accurately localize the source of pain, and when the pain is localized it may actually be referred from above or below the painful region, adding to the difficulty in diagnosis [12,13].

The conditions to be considered will depend in part on the patient's age. Common conditions leading to a limping child include soft-tissue or bone injuries; infection of the bone, soft tissues or joints; and neuromuscular, congenital, developmental, ischemic, and neoplastic processes.

In one prospective study of 243 children under 14 years of age presenting with a limp [14], the most common diagnosis was transient synovitis. There are many less common causes as well. The patient may have a self-limited problem, but could also have a traumatic, inflammatory, or neoplastic condition requiring diagnosis and treatment [15]. Some entities such as septic arthritis require rapid diagnosis to prevent or limit adverse outcomes [16]. Others can be diagnosed in a more temperate fashion, based on clinical course. A detailed history and complete physical exam are essential in assessing a child with a limp [3]. In many cases, no imaging is required, while others may require extensive imaging evaluation.

No large prospective studies have been performed to evaluate imaging algorithms in the child presenting with a limp. However, studies have examined individual diagnoses that lead to this presentation. Even in children with trauma, there is discussion about the appropriate radiologic evaluation.

Radiography has been used extensively in evaluating the limping child. It allows for a rapid overview, and triage and is recommended in many imaging algorithms

[1,10,13,17,18]. Usually, radiographs of the entire lower extremity, including the feet, have been obtained due to the relatively high prevalence of occult fracture [13]. However, studies by McConnochie et al [19] demonstrated that as many as 26% of lower-extremity radiographs in injured children could be avoided with only a 5% incidence of missed fractures if clinical criteria were used in selecting patients for radiography.

Similarly, Rivara et al [20] demonstrated that examination for gross deformity and pain on motion predicted lower-extremity fractures in the post-trauma setting, with 97% of children with fractures being correctly identified. In the limping child without a history of trauma, radiographs of the lower extremities are typically normal [21,22]. Oudjhane et al [13] found that fracture was the cause of a limp in 20% of 500 preschoolers who presented with a limp, while Blatt et al [23] found radiographic studies to be normal in 96% of patients presenting with limp, inability to bear weight, or frequent falling, and the few abnormalities identified were relatively insignificant. On the other hand, radiographs is all that is required for detection of diagnoses such as slipped capital femoral epiphysis, permitting early surgical intervention [12,24].

Ultrasonographic evaluation has mainly been used in evaluating the irritable hip [25]. Terjesen and Osthus [26] found that ultrasound (US) was helpful as the primary imaging technique in transient synovitis, with radiography being unnecessary in uncomplicated cases. Fischer et al [14] found toxic synovitis to be the most common diagnosis in the child with a limp, and they routinely use US as the primary imaging modality, reserving radiographs for cases where the US was negative. However, a false negative rate of 5% was reported in one study due to inadequate exams or very early scanning [27]. Royle [28] found similar findings, reserving radionuclide bone scans for those with positive findings on US. US guidance can also be useful in guiding joint aspiration to differentiate septic arthritis from toxic synovitis, particularly in the hip.

Aspiration is the gold standard in differentiating toxic synovitis from septic arthritis [25,29,30], but others suggest that not all effusions need to be aspirated [16,31,32]. In a prospective study of 53 children who had undergone US-guided aspiration because of an irritable hip, Caird et al [16] found that fever, an elevated C-reactive protein level, an elevated erythrocyte sedimentation rate, lack of weight-bearing, and an elevated serum white-blood-cell count were predictors of septic arthritis. The probability of septic arthritis was estimated to be 98% when five predictors were present, 93% when four predictors were present, and 83% when three predictors were present. US can also detect alternate diagnoses such as osteomyelitis [33] and Legg-Perthes disease [34].

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Radionuclide bone scans have been shown to be efficacious in evaluating limping children younger than 5 years of age, particularly when the exam is nonfocal [35,36]. Englaro et al [22] studied patients without a history of infection, child abuse, malignancy, or radiographic abnormalities of the lower extremities and found that 30 out of 56 patients had abnormal bone scans. Aronson et al [21] studied a group of 50 patients who had no diagnosis after clinical, laboratory, and radiographic evaluation. They found that 54% of the patients had abnormal bone scans localized to a specific region. Bone scan also plays a role in diagnosis and prognosis in Legg-Calve-Perthes disease [37], where the scintigraphic finds may predict the severity of the disease progression. Fluorodeoxyglucose positron emission tomography (FDG-PET) imaging and leukocyte scintigraphy can be useful in chronic osteomyelitis, outperforming magnetic resonance imaging (MRI) and radiographs in a study by Termaat et al [38].

Due to radiation concerns and the efficacy of other imaging modalities, the role of computed tomography is limited in the child with a limp. It can be useful in preoperative evaluation of known fracture [39] and in identifying osteopenia in a small subgroup of children with negative MRI evaluation for stress fracture [40].

MRI is useful in a number of different conditions that lead to a limp in a child. It can detect many early stress fractures [40,41], detect early Legg-Perthes disease [42-48], and osteomyelitis [49-52]. It may even help in differentiating toxic synovitis from septic arthritis, as bone marrow signal abnormalities are seen more commonly in septic arthritis [53,54]. Whole-body MRI may also be helpful in children with multifocal lesions [55]. MRI can also help in differentiating bone infarcts from osteomyelitis [56].

In summary, the evaluation of the child with a limp must start first with a detailed history and physical examination, including an analysis of gait. If the cause of limping is evident clinically (neuromuscular disease or minor trauma), further assessment may be unnecessary. If the patient's pain can be accurately localized clinically, appropriate radiographic views of the area should be obtained. However, if the source of the limp cannot be localized, a medical decision will first have to be made whether imaging assessment is initially required or if further clinical observation is appropriate. For patients who have persistent signs and symptoms, or a clinical assessment that points to the possibility of significant trauma, infection, or tumor as the cause of the problem, consideration should be given to performing additional radiographs, US, MRI, or radionuclide bone scan.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF), also known as nephrogenic fibrosing dermopathy) was first identified

in 1997 and has recently generated substantial concern among radiologists, referring doctors and lay people. Until the last few years, gadolinium-based MR contrast agents were widely believed to be almost universally well tolerated, extremely safe and non-nephrotoxic, even when used in patients with impaired renal function. All available experience suggests that these agents remain generally very safe, but recently some patients with renal failure who have been exposed to gadolinium contrast agents (the percentage is unclear) have developed NSF [57-59], a syndrome that can be fatal. Further studies are necessary to determine what the exact relationships are between gadolinium-containing contrast agents, their specific components and stoichiometry, patient renal function and NSF. Current theory links the development of NSF to the administration of relatively high doses (eg, >0.2mM/kg) and to agents in which the gadolinium is least strongly chelated. The FDA has recently issued a “black box” warning concerning these contrast agents (http://www.fda.gov/cder/drug/InfoSheets/HCP/gcca_2_00705HCP.pdf).

This warning recommends that, until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated GFR <30 mL/min/1.73m²), recent liver or kidney transplant or hepato-renal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in the particular patient clearly outweighs the potential risk(s) [58].

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. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

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Relative Radiation Level Designations	
Relative Radiation Level*	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

*RRL assignments are not included for some examinations. The RRL assignments for the NS (not specified) exams cannot be made because the RRL depends on the region of the body exposed to ionizing radiation, and the body part will vary as a function of the clinical situation.

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