American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Limping Child — Ages 0-5 Years**

Variant 1: **Nonfocal clinical examination.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray pelvis and lower extremity	8	Pelvis, femur (including knee), lower leg and foot are all imaged.	☢☢
Tc-99m 3-phase bone scan lower extremity	6	Follow-up study when limping persists and radiographs negative.	☢☢☢
MRI pelvis and lower extremity	6	Follow-up study as needed. See statement regarding contrast in text under "Anticipated Exceptions."	O
US hip	5	Follow-up study as needed.	O
X-ray spine	3		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Focal clinical examination (not septic arthritis).**

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	Consider imaging region above and below area of concern.	NS
Tc-99m 3-phase bone scan lower extremity	7	Follow-up study as needed.	☢☢☢
MRI area of interest	7	Follow-up study as needed. Use contrast as clinically indicated. See statement regarding contrast in text under "Anticipated Exceptions."	O
US area of interest	3		O
CT area of interest	2		NS
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually 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.	O
Tc-99m 3-phase bone scan lower extremity	7	Follow-up study as needed.	☢☢☢
MRI area of interest	7	Follow-up study as needed. See statement regarding contrast in text under "Anticipated Exceptions."	O
CT area of interest	2		NS
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Expert Panel on Pediatric Imaging: Lynn Fordham, MD[1]; Richard Gunderman, MD, PhD[2]; Ellen R. Blatt, MD[3]; Dorothy Bulas, MD[4]; Brian D. Coley, MD[5]; Daniel J. Podberesky, MD[6]; Jeffrey Scott Prince, MD[7]; Laura Tosi, MD.[8]

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].

Radionuclide bone scans have been shown to be efficacious in evaluating limping children younger than 5

[1]Principal Author, University of North Carolina, Chapel Hill, North Carolina.
[2]Panel Chair, Riley Hospital for Children, Indiana University, Indianapolis, Indiana.
[3]The Children's Hospital, Denver, Colorado.
[4]Children's National Medical Center, Washington, District of Columbia.
[5]Columbus Children's Hospital, Columbus, Ohio.
[6]Wilford Hall Medical Center, Lackland Air Force Base, Texas.
[7]Primary Children's Medical Center, Salt Lake City, Utah.
[8]Childrens National Medical Center, Washington, District of Columbia, American Academy of Orthopaedic Surgeons.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

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) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [57].

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, both because of 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 to 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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence table under review

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