

**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.	Min
NUC bone scan 3-phase 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 Expectations.”	None
US hip	5	Follow-up study as needed.	None
X-ray spine	3		Low
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 bone scan 3-phase 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 Expectations.”	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 bone scan 3-phase 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 Expectations.”	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.

Plain-film 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, plain 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, plain film 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 plain film 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

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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 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 plain-films 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 plain films 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 plain films, 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_200705HCP.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/1.73m), 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].

References

1. Barkin RM, Barkin SZ, Barkin AZ. The limping child. *J Emerg Med* 2000; 18(3):331-339.
2. Blickman JG, van Die CE, de Rooy JW. Current imaging concepts in pediatric osteomyelitis. *Eur Radiol* 2004; 14 Suppl 4:L55-64.
3. De Boeck H, Vorlat P. Limping in childhood. *Acta Orthop Belg* 2003; 69(4):301-310.
4. De Inocencio J. Epidemiology of musculoskeletal pain in primary care. *Arch Dis Child* 2004; 89(5):431-434.
5. Flynn JM, Widmann RF. The limping child: evaluation and diagnosis. *J Am Acad Orthop Surg* 2001; 9(2):89-98.
6. Frank G, Mahoney HM, Eppes SC. Musculoskeletal infections in children. *Pediatr Clin North Am* 2005; 52(4):1083-1106, ix.
7. Gunner KB, Scott AC. Evaluation of a child with a limp. *J Pediatr Health Care* 2001; 15(1):38-40.
8. Leet AI, Skaggs DL. Evaluation of the acutely limping child. *Am Fam Physician* 2000; 61(4):1011-1018.
9. Newberg AH, Newman JS. Imaging the painful hip. *Clin Orthop Relat Res* 2003; (406):19-28.

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10. Swischuk LE. Emergency pediatric imaging: changes over the years. Part II. *Emerg Radiol* 2005; 11(5):253-261.
11. Leung AK, Lemay JF. The limping child. *J Pediatr Health Care* 2004; 18(5):219-223.
12. Katz DA. Slipped capital femoral epiphysis: the importance of early diagnosis. *Pediatr Ann* 2006; 35(2):102-111.
13. Oudjhane K, Newman B, Oh KS, Young LW, Girdany BR. Occult fractures in preschool children. *J Trauma* 1988; 28(6):858-860.
14. Fischer SU, Beattie TF. The limping child: epidemiology, assessment and outcome. *J Bone Joint Surg Br* 1999; 81(6):1029-1034.
15. Goncalves M, Terreri MT, Barbosa CM, Len CA, Lee L, Hilario MO. Diagnosis of malignancies in children with musculoskeletal complaints. *Sao Paulo Med J* 2005; 123(1):21-23.
16. Caird MS, Flynn JM, Leung YL, Millman JE, D'Italia JG, Dormans JP. Factors distinguishing septic arthritis from transient synovitis of the hip in children. A prospective study. *J Bone Joint Surg Am* 2006; 88(6):1251-1257.
17. Fordham L, Auringer ST, Frush DP. Pediatric imaging perspective: acute limp. *J Pediatr* 1998; 132(5):906-908.
18. Saigal G, Azouz EM, Abdenour G. Imaging of osteomyelitis with special reference to children. *Semin Musculoskelet Radiol* 2004; 8(3):255-265.
19. McConnochie KM, Roghmann KJ, Pasternack J, Monroe DJ, Monaco LP. Prediction rules for selective radiographic assessment of extremity injuries in children and adolescents. *Pediatrics* 1990; 86(1):45-57.
20. Rivara FP, Parish RA, Mueller BA. Extremity injuries in children: predictive value of clinical findings. *Pediatrics* 1986; 78(5):803-807.
21. Aronson J, Garvin K, Seibert J, Glasier C, Tursky EA. Efficiency of the bone scan for occult limping toddlers. *J Pediatr Orthop* 1992; 12(1):38-44.
22. Englaro EE, Gelfand MJ, Paltiel HJ. Bone scintigraphy in preschool children with lower extremity pain of unknown origin. *J Nucl Med* 1992; 33(3):351-354.
23. Blatt SD, Rosenthal BM, Barnhart DC. Diagnostic utility of lower extremity radiographs of young children with gait disturbance. *Pediatrics* 1991; 87(2):138-140.
24. Rahme D, Comley A, Foster B, Cundy P. Consequences of diagnostic delays in slipped capital femoral epiphysis. *J Pediatr Orthop B* 2006; 15(2):93-97.
25. Zawin JK, Hoffer FA, Rand FF, Teele RL. Joint effusion in children with an irritable hip: US diagnosis and aspiration. *Radiology* 1993; 187(2):459-463.
26. Terjesen T, Osthus P. Ultrasound in the diagnosis and follow-up of transient synovitis of the hip. *J Pediatr Orthop* 1991; 11(5):608-613.
27. Gordon JE, Huang M, Dobbs M, Luhmann SJ, Szymanski DA, Schoenecker PL. Causes of false-negative ultrasound scans in the diagnosis of septic arthritis of the hip in children. *J Pediatr Orthop* 2002; 22(3):312-316.
28. Royle SG. Investigation of the irritable hip. *J Pediatr Orthop* 1992; 12(3):396-397.
29. Do TT. Transient synovitis as a cause of painful limps in children. *Curr Opin Pediatr* 2000; 12(1):48-51.
30. Luhmann SJ, Jones A, Schootman M, Gordon JE, Schoenecker PL, Luhmann JD. Differentiation between septic arthritis and transient synovitis of the hip in children with clinical prediction algorithms. *J Bone Joint Surg Am* 2004; 86-A(5):956-962.
31. Kocher MS, Mandiga R, Zurakowski D, Barnewolt C, Kasser JR. Validation of a clinical prediction rule for the differentiation between septic arthritis and transient synovitis of the hip in children. *J Bone Joint Surg Am* 2004; 86-A(8):1629-1635.
32. Skinner J, Glancy S, Beattie TF, Hendry GM. Transient synovitis: is there a need to aspirate hip joint effusions? *Eur J Emerg Med* 2002; 9(1):15-18.
33. Azam Q, Ahmad I, Abbas M, Syed A, Haque F. Ultrasound and colour Doppler sonography in acute osteomyelitis in children. *Acta Orthop Belg* 2005; 71(5):590-596.
34. Terjesen T. Ultrasonography in the primary evaluation of patients with Perthes disease. *J Pediatr Orthop* 1993; 13(4):437-443.
35. Connolly LP, Connolly SA. Skeletal scintigraphy in the multimodality assessment of young children with acute skeletal symptoms. *Clin Nucl Med* 2003; 28(9):746-754.
36. Connolly LP, Treves ST. Assessing the limping child with skeletal scintigraphy. *J Nucl Med* 1998; 39(6):1056-1061.
37. Comte F, De Rosa V, Zekri H, et al. Confirmation of the early prognostic value of bone scanning and pinhole imaging of the hip in Legg-Calve-Perthes disease. *J Nucl Med* 2003; 44(11):1761-1766.
38. Termaat MF, Raijmakers PG, Scholten HJ, Bakker FC, Patka P, Haarman HJ. The accuracy of diagnostic imaging for the assessment of chronic osteomyelitis: a systematic review and meta-analysis. *J Bone Joint Surg Am* 2005; 87(11):2464-2471.
39. Cutler L, Molloy A, Dhukuram V, Bass A. Do CT scans aid assessment of distal tibial physeal fractures? *J Bone Joint Surg Br* 2004; 86(2):239-243.
40. Gaeta M, Minutoli F, Scribano E, et al. CT and MR imaging findings in athletes with early tibial stress injuries: comparison with bone scintigraphy findings and emphasis on cortical abnormalities. *Radiology* 2005; 235(2):553-561.
41. Ishibashi Y, Okamura Y, Otsuka H, Nishizawa K, Sasaki T, Toh S. Comparison of scintigraphy and magnetic resonance imaging for stress injuries of bone. *Clin J Sport Med* 2002; 12(2):79-84.
42. Gent E, Antapur P, Fairhurst J, Taylor GR, Clarke NM. Perthes' disease in the very young child. *J Pediatr Orthop B* 2006; 15(1):16-22.
43. Huang GS, Chan WP, Chang YC, Chang CY, Chen CY, Yu JS. MR imaging of bone marrow edema and joint effusion in patients with osteonecrosis of the femoral head: relationship to pain. *AJR* 2003; 181(2):545-549.
44. Kaniklides C, Lonnerholm T, Moberg A, Sahlstedt B. Legg-Calve-Perthes disease. Comparison of conventional radiography, MR imaging, bone scintigraphy and arthrography. *Acta Radiol* 1995; 36(4):434-439.
45. Kramer PP. The value of MRI in early Perthes' disease. *Pediatr Radiol* 1998; 28(3):196-197.
46. Lahdes-Vasama T, Lamminen A, Merikanto J, Martinen E. The value of MRI in early Perthes' disease: an MRI study with a 2-year follow-up. *Pediatr Radiol* 1997; 27(6):517-522.
47. Lamer S, Dorgeret S, Khairouni A, et al. Femoral head vascularisation in Legg-Calve-Perthes disease: comparison of dynamic gadolinium-enhanced subtraction MRI with bone scintigraphy. *Pediatr Radiol* 2002; 32(8):580-585.
48. Mahnken AH, Staatz G, Ihme N, Gunther RW. MR signal intensity characteristics in Legg-Calve-Perthes disease. Value of fat-suppressed (STIR) images and contrast-enhanced T1-weighted images. *Acta Radiol* 2002; 43(3):329-335.
49. Kim J, Jaramillo D. Imaging of acute hematogenous osteomyelitis and septic arthritis in children and adults. In: Medina LS, Blackmore CC, eds. *Evidence-Based Imaging: Optimizing Imaging in Patient Care*. New York: Springer; 2006:591.
50. Koulouris G, Morrison WB. MR imaging of hip infection and inflammation. *Magn Reson Imaging Clin N Am* 2005; 13(4):743-755.
51. Tas F, Ogun S, Bulut O, Bulut S, Isik AO. Comparison of the diagnosis of plain radiography ultrasonography and magnetic resonance imaging in early diagnosis of acute osteomyelitis experimentally formed on rabbits. *Eur J Radiol* 2005; 56(1):107-112.
52. White PM, Boyd J, Beattie TF, Hurst M, Hendry GM. Magnetic resonance imaging as the primary imaging modality in children presenting with acute non-traumatic hip pain. *Emerg Med J* 2001; 18(1):25-29.

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53. Lee SK, Suh KJ, Kim YW, et al. Septic arthritis versus transient synovitis at MR imaging: preliminary assessment with signal intensity alterations in bone marrow. *Radiology* 1999; 211(2):459-465.
54. Yang WJ, Im SA, Lim GY, et al. MR imaging of transient synovitis: differentiation from septic arthritis. *Pediatr Radiol* 2006; 36(11):1154-1158.
55. Mentzel HJ, Kentouche K, Sauner D, et al. Comparison of whole-body STIR-MRI and ^{99m}Tc-methylene-diphosphonate scintigraphy in children with suspected multifocal bone lesions. *Eur Radiol* 2004; 14(12):2297-2302.
56. Umans H, Haramati N, Flusser G. The diagnostic role of gadolinium enhanced MRI in distinguishing between acute medullary bone infarct and osteomyelitis. *Magn Reson Imaging* 2000; 18(3):255-262.
57. Broome DR, Girguis MS, Baron PW, Cottrell AC, Kjellin I, Kirk GA. Gadodiamide-associated nephrogenic systemic fibrosis: why radiologists should be concerned. *AJR* 2007; 188(2):586-592.
58. Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document for safe MR practices: 2007. *AJR* 2007; 188(6):1447-1474.
59. Sadowski EA, Bennett LK, Chan MR, et al. Nephrogenic systemic fibrosis: risk factors and incidence estimation. *Radiology* 2007; 243(1):148-157.

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