Acute and Non-acute Lower Extremity Pain in the Pediatric Population: Part I

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KEY WORDS
Pediatric/child limp, antalgic gait, leg pain, lower extremity pain

Lower extremity musculoskeletal pain is common in childhood and affects up to 16% of the school-aged population (Junnilla & Cartwright, 2006a). While musculoskeletal pain is common, the possible etiologies are broad, ranging from benign to serious. A presenting complaint of lower extremity musculoskeletal pain may be due to trauma, inflammatory conditions, infection, or hematologic or oncologic processes, to name a few (Junnilla & Cartwright, 2006a; Junnilla & Cartwright, 2006b; Kapoor, 2009). Although most musculoskeletal pain can be traced to a benign condition, one must remember that neoplastic processes can mimic many other diseases (Trueworthy & Templeton, 2002). Children who present with musculoskeletal pain must be evaluated appropriately.

After performing an extensive literature review, we found many articles that address acute or chronic musculoskeletal pain in children. However, we felt the need for a comprehensive practice guideline for treatment of pediatric lower extremity pain that includes a broad base of acute and non-acute etiologies. The goal of this practice guideline is to present tools a provider can use to determine the diagnosis for a child with lower extremity pain in an efficient manner. This practice guideline, which is divided into two parts, is a reference for providers who are caring for a patient with lower extremity pain.
musculoskeletal pain. Part I will focus on the differential diagnosis, history, physical examination, diagnostic studies to order (with a reference table), and a brief summary of possible diagnoses, with inclusion of an algorithm. Part II will focus on a summary of possible diagnoses with a reference table and algorithm; a discussion of etiology and a description of possible diagnoses; key history and physical examination findings; diagnostic studies to order; and recommended treatment(s) and when to refer to subspecialty provider(s).

ETIOLOGY
Evaluation of musculoskeletal pain of the lower extremity requires a thorough history and an in-depth physical examination. This combination will help the provider determine whether imaging and laboratory tests are needed. Awareness of the typical presentation and possible differential diagnoses can reduce the risk of misdiagnosis (Junnilla & Cartwright, 2006a; Kapoor, 2009).

The etiology of musculoskeletal pain, with or without a limp, is broad. Below are commonly seen etiologies for musculoskeletal pain. The diagnoses can be grouped into the following categories:

- Trauma: strains/sprains, fractures, and dislocations
- Infection: septic arthritis, osteomyelitis, and Brodie’s abscess
- Immune-mediated: toxic synovitis, juvenile idiopathic arthritis, Lyme disease, strep reactive arthritis, and osteoid osteoma
- Acquired: slipped capital femoral epiphysis and Legg-Calve-Perthes disease
- Neoplastic: leukemia/lymphoma, Ewing’s sarcoma, and osteosarcoma
- Referred: discitis, psoas abscess, and spine or hip pathology
- Benign musculoskeletal: growing pains and tendinitis/apophysitis

Although the primary purpose of the guideline is to focus on musculoskeletal pain, providers may encounter additional non-painful causes of a gait disturbance when evaluating a child with a limp. When families see their child limping, they often presume the child is in pain. It is important to remember a limp may or may not be related to a painful condition. Therefore the following additional non-painful etiologies should be considered:

- Congenital: developmental dysplasia of the hip
- Non-painful limp: leg length discrepancy and scoliosis

HISTORY
An in-depth history often will provide the most helpful information for the diagnosis. As indicated by Junnilla and Cartwright, “A logical and consistent approach to diagnosis is necessary to treat the pain and its cause to effectively avoid the long-term complications of untreated disease” (2006a, p. 115). The vast majority of the clinic visit is spent focused on the history of the present symptoms, because it is the history that most often will aid the provider in the diagnosis (Herring, 2007; Wenger & Rang, 1993). The history is especially helpful in the young and/or non-verbal population. Guidelines that can help a provider make a diagnosis are provided below.

Chief Complaint
One should begin by reviewing the chief complaint with the patient’s care provider and patient, if possible. The following suggested questions can help the clinician obtain a comprehensive history.

History of Pain
Most often the etiology of musculoskeletal pain is related to accidental injury and not physical abuse. Sprains, strains, and contusions are common. The following questions should be asked:

- What was the child doing prior to the event?
- When did it occur?
- Where did it occur?
- On what body part did the child land?
- What did the child do immediately after the event?
- Did the caregiver identify any swelling, bruising, pain, bleeding, or a change in walking pattern immediately after the incident?
- Where was the child most tender?
- If the child was crying, once he or she was calm, how did the child act leading up to the visit to the health care provider?
- — A traumatic injury followed by a period in which the child is completely asymptomatic raises concern about the possibility of a non-traumatic etiology (Flynn & Widmann, 2001)
- Who witnessed the event?

Timing of Pain
Timing of pain can aid in the diagnosis (Flynn & Widmann, 2001). Acute onset of symptoms suggests a more acute diagnosis such as septic arthritis,
osteomyelitis, fracture, or malignancy. In contrast, symptoms that occur in the morning and improve throughout the day are more suggestive of a rheumatologic etiology. Pain after participating in activities is suggestive of an overuse syndrome or stress fracture. Pain that causes one to wake during the night can be caused by a benign etiology such as growing pains or by more serious etiologies such as malignancy or osteoid osteoma (Flynn & Widmann, 2001). Any preceding activities surrounding the symptoms should be identified. For example, one should ask about a history of trauma, recent upper respiratory infection, recent travels out of the area, or any other unique features (Junnilla & Cartwright, 2006a, 2006b; Staheli, 2007; Staheli & Song, 2007).

The following questions should be asked:

- When did the pain start?
- What makes the pain better?
- What makes the pain worse?
- If activities make the pain worse, what specific activities increase pain?
- Is the pain bad enough to prevent the child from participating in his or her activities, from playing, or from going to school?
- Does the child participate in sports? If so, which ones?
- Does the pain keep the child from participating in sports?
- How does the child feel after participating in sports or play activities?
- Does the pain wake the child at night? Does the pain occur during the day, in the morning, or after naps?
- Do the joints have any associated swelling or warmth?

**Associated Systemic Features**

Serious conditions typically will cause systemic symptoms. The following questions should be asked:

- Are fevers present, and if so, when do they occur?
- Is the pain associated with any rashes, weight loss, change in activity, decreased appetite, lethargy, and/or a change in sleep patterns? (Morrissy & Weinstein, 2006).

One should be concerned when children stop playing or teens limit participation in athletics or social activities (Flynn & Widmann, 2001).

**Nature and Location of Pain**

Often the specific location of the pain can be difficult for children to identify, characterize, and localize (Junnilla & Cartwright, 2006a; Staheli, 2007; Staheli & Song, 2007). Children often find it easier to demonstrate the location of the pain. In verbal children, it may be beneficial to use their index finger to identify the point of maximum tenderness. The following questions should be asked:

- If you could show me the one exact place that hurts the most, where would that be? (Ask the child to use his or her finger to identify this spot)
  — Children who are unable to locate the area of maximum tenderness should be asked to draw a line with their finger demonstrating where the pain starts and stops;

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**FIGURE. Lower extremity pain differential diagnosis algorithm. Data from Gedalia, 2002; Junnilla & Cartwright, 2006a; and Sawyer & Kapoor, 2009.**
in non-verbal children, one should rely on
the parent’s perceptions of where the pain
is located
- Can you describe the pain?
- Where does the pain start?
- Where does the pain stop?

Medical history
Along with an in-depth history of the present illness, the
following information should be confirmed: the pa-tient’s general medical history, surgical history, family
medical history, developmental milestones, recent travels or recent unique features within the family’s so-
cial environment, and birth history (Leet & Skaggs, 2000; Morrissy & Weinstein, 2006; Staheli, 2007; Staheli & Song, 2007).

PHYSICAL EXAMINATION
A thorough musculo-skeletal examination is important for diagno-sis. The focused muscu-
oskeletal examination includes pediatric orthopedic, neurologic, and rheumatologic aspects. One should al-
ways start with a presumed non-painful area, especially in small children, and perform the examination of the painful area last (Herring, 2007; Kapoor, 2009; Laine, Kaiser, & Diab, 2010; Morrissy & Weinstein, 2006; Wenger & Rang, 1993).

Orthopedic Examination:
- Inspect and palpate both lower extremities
  — Identify the site of maximal tenderness
- Examine the joints for swelling and range of motion
- Evaluate range of motion to all upper and lower extremities including bilateral shoulders, elbows, wrists and fingers, hips, knees, ankles, and toes
  — Be aware of the knee-hip-back triad; hip pain often is referred to the knee, back pain can refer to the hip, and radicular pain from the spine presents with pain down the leg
  — When evaluating knee pain, always include evaluation of the hip
- Include palpation of all extremities
  — Assess for joint range limitation, warmth, and swelling

Neurologic Examination:
- Evaluate the undressed child through several gait cycles, paying attention to each limb and joint
  — Running may help uncover subtle gait abnormalities
  — To minimize pain in the affected limb, the amount of time spent in the stance phase decreases and that spent in the swing phase increases (Barkin et al., 2000; Herring, 2007; Laine et al., 2010; Leet & Skaggs, 2000; Renshaw, 1995; Wyndam, 2007)
- Examine deep tendon reflexes, tone, clonus, sen-sation, straight leg raise, and muscle wasting and evaluate the feet and toes for clawing or deformity (Herring, 2007; Leet & Skaggs, 2000; Morrissy & Weinstein, 2006; Wenger & Rang, 1993)
  — A positive neurologic examination finding is suggestive of an etiology from either the spi-nal cord or a nerve root

DIFFERENTIAL DIAGNOSIS
The differential diagnosis for a child with lower extrem-
ity pain is extensive. With a thorough history and phys-
ical examination, each diagnostic possibility has key
features to assist the provider in developing a differen-
tial diagnosis. We have developed an algorithm to help
the provider develop a list of the top differential diagno-
ses (Figure).

DIAGNOSTIC STUDIES
As seen on the algorithm, specific diagnostic studies
and/or laboratory studies can be used to help confirm
a diagnosis. An in-depth discussion of specific diagno-
stic studies commonly used in the diagnosis of lower ex-
tremity pain is provided in the following section.

Diagnostic Imaging Studies
Radiographs
- Plain films of the lower extremity are among the first tests ordered to evaluate pain, with or without a history of trauma
  — It is usually worth ruling out a fracture because physeal injuries are more common than ligamentous injuries in children (Leet & Skaggs, 2000; Staheli, 2007; Staheli & Song, 2007)
  — Radiographs may provide the ability to rule out fractures, bony lesions, periosteal reac-
tion, avascular necrosis, and some joint effu-
sions (Leung & Lemay, 2004; Staheli, 2007; Staheli & Song, 2007)
- Anterior posterior and lateral radiographs of the entire limb should be obtained, including the joints above and below the area of pain
- Anterior posterior and frog lateral views of the pelvis should be obtained if the hip is suspected as the source of pain
  — One then can compare the contralateral side, because findings often can be subtle (Myers & Thompson, 1997)
Posterior anterior and lateral spine films should be obtained if spinal pathology is suspected as the source of lower extremity pain (Herring, 2007; Staheli, 2007; Staheli & Song, 2007). Note that initial imaging may be normal in the case of stress fractures, Perthes disease, osteomyelitis, or septic arthritis (Sawyer & Kapoor, 2009).

Radionuclide bone scintigraphy
- A bone scan often can help in localizing the source of pain when radiographs are normal.
  - Although it is not specific, a bone scan can help locate infectious and neoplastic processes, along with occult fractures and avascular necrosis (Barkin et al., 2000; Staheli, 2007; Staheli & Song, 2007).

Ultrasounds
- When an effusion of the hip or other joint(s) is suspected, an ultrasound can be obtained (Staheli, 2007; Staheli & Song, 2007).

Magnetic resonance imaging
- A magnetic resonance imaging scan can be a useful test to further elicit a diagnosis.
  - Magnetic resonance imaging is best used for defining intra-articular derangements, bone or soft tissue tumors, bone or soft tissue infections, and for evaluating spinal canal involvement (De Boeck & Vorlat, 2003; Morrissy & Weinstein, 2006).

Computer axial tomography
- When a bony abnormality is suspected on X-ray and further definition is needed, a computed tomography scan can be helpful.
  - It is best to use computer axial tomography judiciously because of the high radiation exposure.
- Computer axial tomography often is used to help determine the presence of tarsal coalitions (De Boeck & Vorlat, 2003; Morrissy & Weinstein, 2006; Staheli, 2007; Staheli & Song, 2007).

### TABLE. Laboratory tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Condition</th>
<th>Expected finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC</td>
<td>Infection</td>
<td>Elevated WBC and platelets</td>
</tr>
<tr>
<td></td>
<td>Inflammation</td>
<td>Elevated WBC and platelets</td>
</tr>
<tr>
<td></td>
<td>Malignancy</td>
<td>Cytopenia</td>
</tr>
<tr>
<td>CRP</td>
<td>Infection</td>
<td>Elevated</td>
</tr>
<tr>
<td></td>
<td>Inflammation</td>
<td>Elevated</td>
</tr>
<tr>
<td></td>
<td>Malignancy</td>
<td>Elevated</td>
</tr>
<tr>
<td>ESR</td>
<td>Infection</td>
<td>Elevated</td>
</tr>
<tr>
<td></td>
<td>Inflammation</td>
<td>Elevated</td>
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<tr>
<td></td>
<td>Malignancy</td>
<td>Elevated</td>
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<tr>
<td>ASO</td>
<td>Acute rheumatic fever</td>
<td>Markedly increased and usually very ill child</td>
</tr>
<tr>
<td></td>
<td>Unresolved/undetected Group A hemolytic streptococcus</td>
<td>Increased ASO, sore throat</td>
</tr>
<tr>
<td>AntiDNAse B</td>
<td>Acute rheumatic fever</td>
<td>Positive and usually very ill child</td>
</tr>
<tr>
<td></td>
<td>Unresolved/undetected Group A hemolytic streptococcus</td>
<td>Positive</td>
</tr>
<tr>
<td>ANA</td>
<td>SLE</td>
<td>Markedly positive</td>
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<tr>
<td></td>
<td>False positive</td>
<td>Mildly positive</td>
</tr>
<tr>
<td>Lyme</td>
<td>Lyme disease</td>
<td>Titer positive and Western blot positive</td>
</tr>
<tr>
<td>Synovial cell count</td>
<td>Septic arthritis</td>
<td>Turbid fluid; WBC &gt; 50,000 to &gt; 100,000; PMNs &gt; 75%</td>
</tr>
<tr>
<td></td>
<td>Transient synovitis</td>
<td>Clear yellow synovial fluid; WBC 5000–15,000; PMNs &lt; 25%</td>
</tr>
<tr>
<td>Blood Cx</td>
<td>Infection</td>
<td>Culture may be positive or negative</td>
</tr>
<tr>
<td>Joint/bone Cx</td>
<td>Infection</td>
<td>Culture may be positive or negative</td>
</tr>
<tr>
<td>Stool Cx</td>
<td>Reactive arthritis with diarrhea</td>
<td>Salmonella, Shigella, Yersinia, Campylobacter</td>
</tr>
<tr>
<td>Urine Cx</td>
<td>Reactive arthritis</td>
<td>Neisseria gonorrhoeae or Chlamydia</td>
</tr>
<tr>
<td>Serum ferritin</td>
<td>RLS</td>
<td>Meet NIH RLS criteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Serum ferritin &lt; 50 μg</td>
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</tbody>
</table>

ANA, antinuclear antibodies; ASO, antistreptolysin; CBC, complete blood cell count; CRP, C reactive protein; Cx, culture; ESR, erythrocyte sedimentation rate; JIA, juvenile inflammatory arthritis; NIH, National Institutes of health; PMN, polymorphonuclear leukocytes; RLS, restless leg syndrome; SLE, systemic lupus erythematosus; WBC, white blood cell count.

Data from Armstrong et al., 2009; Junnilla & Cartwright, 2006a, 2006b; Sawyer & Kapoor, 2009; Thorpy, 2004.
Laboratory Studies

Laboratory studies can help build the case for or even confirm a suspected clinical diagnosis in the case of a child with lower extremity pain in which the history, physical examination, and diagnostic images do not already confirm the diagnosis, or when more information is needed to support a suspected diagnosis. Most laboratory tests are sensitive but not specific. The Table summarizes a number of laboratory tests and expected findings with regard to a specific diagnosis.

- Minimum testing usually includes a complete blood cell count with differential, erythrocyte sedimentation rate, and a C reactive protein (CRP) (Barkin et al., 2000; Herring, 2007; Skaggs & Flynn, 2005; Staheli, 2007; Staheli & Song, 2007)
  - Although an elevated CRP and erythrocyte sedimentation rate can have many causes, an elevated CRP often is considered more sensitive to an acute infectious process
  - If systemic symptoms such as fever, redness, or swelling of a joint are present, a blood culture should be added to the differential
  - If a septic joint is suspected, then the joint should also be aspirated and the sample should be sent for a cell count, gram stain, and anaerobic and aerobic culture
- When a reactive arthritis is considered, antistreptolysin and antiDNAse B tests are added to the minimum levels of testing previously listed (Junnilla & Cartwright, 2006b)
- In special situations, the following studies should be considered:
  - Possible exposure to Lyme disease: Lyme serology with Western blot to confirm if positive
  - Adolescents with possible signs of lupus and pauciarticular juvenile inflammatory arthritis uveitis: antinuclear antibodies
  - The sexually active patient: urine and/or urethral or vaginal testing to help elicit gonococcal or chlamydial arthritis (Junnilla & Cartwright, 2006b; Skaggs & Flynn, 2005)

**BOX. Diagnosis of pediatric lower extremity pain**

<table>
<thead>
<tr>
<th>Diagnoses</th>
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<tr>
<td>Accessory navicular</td>
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<tr>
<td>Apophysitis/musculoskeletal conditions</td>
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<tr>
<td>— Osgood-Schlatter</td>
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<tr>
<td>— Patella femoral pain</td>
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<tr>
<td>— Sinding-Larsen-Johansson syndrome</td>
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<td>— Severs</td>
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<tr>
<td>Cerebral palsy</td>
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<tr>
<td>Complex regional pain syndrome</td>
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<tr>
<td>Developmental dysplasia of the hip</td>
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<tr>
<td>Dislocation</td>
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<tr>
<td>Foreign body</td>
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<tr>
<td>Fracture</td>
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<tr>
<td>Gonococcal/chlamydial arthritis</td>
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<tr>
<td>Growing pains</td>
</tr>
<tr>
<td>Juvenile idiopathic arthritis</td>
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<tr>
<td>Kohler’s disease</td>
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<tr>
<td>Legg-Calve-Perthes disease</td>
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<tr>
<td>Limb length discrepancy</td>
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<tr>
<td>Lyme arthritis</td>
</tr>
<tr>
<td>Neoplasm</td>
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<tr>
<td>Non-accidental trauma</td>
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<tr>
<td>Osteochondritis dissecans</td>
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<tr>
<td>Osteomyelitis</td>
</tr>
<tr>
<td>Restless leg syndrome</td>
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<tr>
<td>Rickets</td>
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<tr>
<td>Scoliosis</td>
</tr>
<tr>
<td>Septic joint</td>
</tr>
<tr>
<td>Slipped capital femoral epiphysis</td>
</tr>
<tr>
<td>Spondylolisthesis/spinal stenosis</td>
</tr>
<tr>
<td>Strain/sprain</td>
</tr>
<tr>
<td>Tarsal coalition</td>
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<td>Toxic synovitis</td>
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</table>

**DIAGNOSIS, TREATMENT, AND REFERRAL**

Once the provider has determined the most likely diagnosis, the next step is to determine appropriate treatment or, if indicated, referral to a specialist for definitive care. Occasionally further specific diagnostic testing is required to confirm the diagnosis. The Box lists the most common lower extremity pain diagnoses.

If systemic symptoms such as fever, redness, or swelling of a joint are present, a blood culture should be added to the differential.

**CONCLUSION**

The number of possible differential diagnoses for pediatric lower extremity pain is large, ranging from a straightforward ankle sprain to a complex neoplastic process. However, with a thorough history, a detailed physical examination, and a systematic approach to the workup, the correct diagnosis usually can be made in a timely manner. Once an accurate diagnosis is made, the provider must then initiate an appropriate treatment plan, with referral to one or more subspecialists when necessary. Part II of this guideline will focus on a description of all the diagnoses listed in the Box, including the etiology, key findings, and more
detailed treatment plans and referral recommendations.

REFERENCES