Apophysitis and Apophyseal Avulsion of the Pelvis

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The phrase “children are not little adults” is a popular adage among health professionals caring for children. This saying holds true for overuse injuries in young athletes. Children and adolescents, with their immature skeletons, have different injury patterns than those exhibited by skeletally mature individuals. Strains of muscles that span the hip and attach to the pelvis are a common cause of hip pain in adult athletes, and these injuries can occur in younger patients as well. In young athletes, irritation of the accessory growth areas of the pelvis (i.e., pelvic apophysitis) and avulsion fractures of the pelvic apophyses are often mistakenly diagnosed as muscle strains or hip pointers. Most clinicians are familiar with Osgood-Schlatter disease, which is an irritation of the apophysis of the tibial tuberosity. Conditions affecting the apophyses of the pelvis are less well known. Clinicians who care for pediatric, adolescent, and young adult athletes should be familiar with the pathophysiology of apophysitis and apophyseal avulsion injuries.

Key Points

- Young athletes have distinctive patterns of injury.
- Irritation and injury to the pelvic growth areas can cause hip pain.
- Apophyseal injuries in young athletes are often mistakenly diagnosed as muscle injuries.

Skeletal Development and Pathophysiology

The skeleton forms in the first weeks of fetal development and is initially composed entirely of cartilage. During subsequent fetal development, and continuing after birth and into childhood and adolescence, the soft cartilage skeleton is transformed into a skeleton made of mineralized bone. This transformation process is known as endochondral ossification. The physis, or growth plate, is the site where endochondral ossification occurs. The cartilage cells of the physis produce an extracellular matrix that ossifies, thereby forming hard bone tissue. This process results in longitudinal bone growth that increases its length. Long bones have a physis at one or both ends. Many bones of the immature skeleton have apophyses, which are growth areas that have muscle attachments in close proximity. Bone growth at the apophyses fills out surface contours, but does not contribute to linear growth. Having open growth plates has many advantages, e.g., fracture healing and remodeling are accelerated in young patients; however, because apophyses and physes are composed of cartilage, they are susceptible to injury. Whereas adults are more likely to experience disruption of ligaments, muscles, and tendons with overuse,
children are more likely to have injuries to the physes and apophyses. Apophysitis refers to irritation of the apophysis, due to repetitive microtrauma that can occur during participation in athletics. With repeated muscle contractions, the apophysis can become irritated and may widen. Apophyseal avulsion fractures generally result from sudden traction generated by a strong eccentric contraction of a muscle group attached adjacent to the affected apophysis.

**Case #1**

A 15-year-old male track athlete presents to the training room with acute onset of right hip pain. He had sudden onset of his pain while sprinting during practice. He recalls feeling a “pop” at the time of injury. He is able to bear weight. On physical exam, he is tender over the anterior superior iliac spine (ASIS). Hip range-of-motion is symmetric, except for slightly decreased extension on the right. He reports pain with passive hip extension and resisted hip flexion. The athletic trainer refers him for radiographs; these demonstrate the presence of an avulsion fracture of the ASIS (Figure 1).

![Figure 1 Avulsion of the anterior superior iliac spine (large white arrow). Other sites where apophysitis can occur are indicated with arrows as follows: iliac crest (gray arrow), ischium (small white arrow), and anterior inferior iliac spine (black arrow).](image)

**Case #2**

A 16-year-old female soccer player presents to the training room with a two-week history of left hip pain. She reports that her pain had an insidious onset; she believes it started while doing soccer kicking drills. She indicates the lateral aspect of the hip as the location of her pain. On physical exam, she is tender along the iliac crest. Hip range of motion is full and symmetric. Subsequent radiographs demonstrate widening of the iliac crest apophysis on the left.

**Anatomy**

The apophyses of the hip and pelvis are located at the anterior superior iliac spine (ASIS), anterior inferior iliac spine (AIIS), ischial tuberosity (IT), pubic symphysis, iliac crest, and greater and lesser trochanters. Knowledge of the bone structure of the hip and pelvis, and muscle origins and insertions, is critical for understanding apophysitis. For example, the iliopsoas is the most powerful of the hip flexors, which inserts on the lesser trochanter. With acute, forceful hip flexion, as the patient in case #1 experienced, the contraction of the iliopsoas can cause avulsion of the lesser trochanter of the apophysis.

The internal and external abdominal oblique muscles insert onto the iliac crest. Repeated trunk rotation puts traction on the iliac crest, which can cause iliac apophysitis, as seen in case #2. Table 1 lists the sites of pelvic apophyses and associated muscles that attach in close proximity.

**Epidemiology**

The exact incidence of pelvic apophysitis is unknown. There are data available for other sites of apophysitis. For example, Kujala et al. surveyed nearly 200 individuals who had been active in athletics during childhood and adolescence and found that 21% had experienced symptoms of Osgood-Schlatter Disease (OSD). Prevalence of OSD was elevated among siblings of athletes with OSD and individuals with a history of Sever Disease (apophysitis of the calcaneus). These data suggest that individuals with apophysitis at one site are more vulnerable to apophysitis at other sites. Poor flexibility is a risk factor, particularly in a muscle attached near the affected apophysis. The individuals with Sever Disease were more likely to have poor flexibility, which may be associated with increased susceptibility to apophysitis at other sites.

Athletes are vulnerable to apophyseal injuries during the time that these growth areas are active. The apophyses of the hip and pelvis generally appear between 13 and 15 years of age, and they close in the early to mid-twenties. The lesser trochanter apophysis
is active earlier, usually appearing between 9 and 13 years of age and closing by 17.2

Rossi and Dragoni3 reviewed the records of over 1200 athletes between the ages of 11 and 35 who had radiographs performed for assessment of hip pain. They found pelvic apophysis avulsion fractures in 16% of these athletes. The average age of the patients with avulsion fractures was 13 (range of 11 to 17), and 68.5% of affected patients were male. Additionally, there were 25 adult patients (ranging in age from 22 to 35) with radiographic evidence of “old” avulsion injuries. Athletes who participated in soccer and gymnastics were most likely to be affected. The ischial tuberosity was the most commonly affected site, followed by the ASIS and the AIIS.3 In another study of 27 patients with apophyseal avulsion fractures, the ASIS was the most commonly affected site.4

### Clinical History and Physical Examination

#### Apophysitis

Apophysitis results from repetitive muscle tension at its attachment site. Patients tend to report an insidious onset of pain. On physical exam, tenderness is elicited by palpation over the apophysis. Pain is often elicited by passive stretch and resisted manual muscle testing, which puts traction on the irritated apophysis. Range of motion is generally unaffected, or minimally reduced.

#### Apophyseal Avulsion

Patients with apophyseal avulsion commonly describe acute onset of pain during an activity that involved forceful muscle contraction. Many recall having felt a “pop” at the time of injury. Athletes may demonstrate an antalgic gait or difficulty ambulating following an avulsion injury. On physical exam, crepitus, swelling, and/or bruising may be apparent. Most patients exhibit significant tenderness in response to palpation of the affected apophysis. They often experience pain during passive stretching and difficulty in actively contracting the muscles attached near the affected apophysis. Range of motion is often limited by pain during the acute postinjury period.

### Diagnostic Imaging

#### Apophysitis

Clinical history and examination provide the primary findings for the diagnosis of apophysitis. In some patients, radiographs demonstrate widening of the apophysis. When radiographs are obtained, they should include the contralateral pelvis and hip for comparison. Magnetic resonance imaging (MRI) is rarely warranted for patients with a clinical history that is strongly suggestive of apophysitis. When performed, MRI may show edema surrounding the affected growth area.5

#### Apophyseal Avulsion

Following an acute injury, radiographs will clearly demonstrate an avulsion fracture.6 With chronic injury, the affected areas may look bulkier than normal, due to new bone formation. The periosteal reaction and new bone formation associated with healing of such an injury may create an appearance that can be confused with a malignant neoplasm (Figure 2). Computed tomography (CT) may be a helpful to ensure the correct diagnosis in such cases.7-9

<table>
<thead>
<tr>
<th>Bone Landmark</th>
<th>Muscle</th>
<th>Muscle Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior superior iliac spine</td>
<td>Sartorius (O)</td>
<td>Hip, knee flexion, external hip location</td>
</tr>
<tr>
<td>Anterior inferior iliac spine</td>
<td>Rectus Femoris (O)</td>
<td>Hip flexion, knee extension</td>
</tr>
<tr>
<td>Ischial Tuberosity</td>
<td>Hamstrings (O)</td>
<td>Hip extension, knee flexion</td>
</tr>
<tr>
<td>Iliac Crest</td>
<td>Abdominal Muscles (I)</td>
<td>Trunk rotation</td>
</tr>
<tr>
<td>Greater Trochanter</td>
<td>Gluteus medius, Gluteus minimus (I)</td>
<td>Hip abduction</td>
</tr>
<tr>
<td>Lesser Trochanter</td>
<td>Iliopsoas (I)</td>
<td>Hip flexion</td>
</tr>
<tr>
<td>Pubic ramus</td>
<td>Adductor longus, brevis, magnus, pectineus, and gracilis (O)</td>
<td>Hip adduction</td>
</tr>
</tbody>
</table>

O-originates, I-inserts
Differential Diagnosis

For symptoms of apophysis over the anterior pelvis, hip, and proximal thigh, including the ASIS, AIIS, pubic ramus, and lesser trochanter, the differential diagnosis includes adductor muscle strain, tendinopathy, snapping hip syndrome, labral tear, and femoroacetabular impingement. Stress fracture, or stress reaction, of the pubic ramus, acetabulum, or femoral neck can also cause pain in this region. Slipped Capital Femoral Epiphysis (SCFE) can be responsible for groin pain in preadolescent and adolescent patients, which must be ruled out in such patients.

Ischial tuberosity apophysitis or apophyseal avulsion may present similar symptoms to those associated with hamstring strain, tendinopathy, or myofascial pain. Referred pain from the lumbar spine can mimic symptoms of apophysitis affecting the ischial tuberosity, lesser trochanter, or greater trochanter. Symptoms associated with iliac crest apophysitis can be confused with those of a strain of an abdominal muscle or irritation of the proximal portion of the iliotibial band. The differential diagnosis for greater trochanter avulsion or apophysitis includes greater trochanteric bursitis and lateral snapping hip syndrome.

For any patient who presents with symptoms associated with pelvic apophyseal irritation or avulsion, clinicians must consider the existence of systemic conditions, such as inflammatory arthritis, malignancy, or infection as potential causes of pain. Intraabdominal abnormalities (e.g., appendicitis) and lumbar spine conditions (e.g., radiculopathy) may cause pain that is referred to the hip and pelvis.

Treatment

Apophysitis

Treatment includes cryotherapy and rest from activity. Athletes can begin gentle stretching when daily activities become pain free, with subsequent progression to strengthening exercises. Activity progression should be gradual, with explosive, plyometric movements involving muscles attached to a site near the affected apophysis added last. Livell et al\textsuperscript{10} recently reported the use of bone stimulator treatment to accelerate healing in two patients with iliac crest apophysitis.

Apophysis Avulsion

Avulsion of a pelvic apophysis generally heals with conservative therapy, including activity restriction and protected weight bearing when the patient has difficulty with ambulation. If pain free after two to four weeks of rest, the patient can progress to gentle stretching and light resistance exercises. Athletes are generally able to return to light sport-specific drills at six weeks after injury and capable of return to full participation at two months after injury if asymptomatic. Clinicians should consider referral for surgical fixation of the avulsed fragment if separated from its normal position by more than 2.5 cm. Most apophysitis avulsion injuries heal with conservative treatment, but surgery may be indicated for nonunion or excessive bone formation at the injury site.\textsuperscript{11} Rossi and Dragoni\textsuperscript{3} reported that only three out of 198 patients required surgery.

Conclusions

Sports medicine clinicians should suspect pelvic apophysitis and apophyseal avulsion fracture in an adolescent or young adult athlete who presents gluteal or hip pain. Individuals with skeletal maturity tend to experience injury to the musculotendinous junction, because it is the weakest portion of the muscle-tendon-bone unit. Individuals with incomplete skeletal growth are more likely to experience injury to the cartilaginous apophysis. Generally, this type of injury heals with conservative therapy, and athletes are eventually capable of returning to the preinjury level of performance.
References


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