Adolescent Femoroacetabular Impingement From Malunion of the Anteroinferior Iliac Spine Apophysis Treated With Arthroscopic Spinoplasty

DEAN K. MATSUDA, MD; CHARITO P. CALIPUSAN, NP

abstract

This article describes a case of an acute anterior inferior iliac spine apophyseal avulsion fracture in an adolescent athlete progressing to secondary symptomatic femoroacetabular impingement from an inferiorly displaced malunion and its arthroscopic management. A 13-year-old boy with an acute minimally displaced avulsion fracture of the anterior inferior iliac spine apophysis had initial symptomatic improvement with conservative treatment and a 3-month symptom-free period but then developed flexion-induced deep anterior groin pain and mechanical symptoms. Radiographs confirmed an inferiorly displaced malunion of the ipsilateral anterior inferior iliac spine apophysis in addition to acetabular retroversion and cam deformity. Surgical treatment, including arthroscopic spinoplasty, was performed. Despite some nonrestrictive heterotopic ossification, the patient had a successful clinical outcome at 18 months, with return to football, and a nonarthritic hip score of 98. Although anterior inferior iliac spine avulsion fractures have historically been considered relatively self-limiting injuries, their malunion may be a previously missed cause of unrelenting or bimodal pain from secondary femoroacetabular impingement with possible degenerative consequences in young athletic patients. Anterior inferior iliac spine avulsion fractures may merit a lower degree of tolerance for displacement in the acute setting and a higher degree of clinical and radiographic scrutiny with surgical intervention, possibly in the form of arthroscopic spinoplasty in the more chronic one.

Dr Matsuda and Ms Calipusan are from the Department of Orthopedics, Southern California Permanente Medical Group, Los Angeles, California.

Dr Matsuda and Ms Calipusan have no relevant financial relationships to disclose.

Correspondence should be addressed to: Dean K. Matsuda, MD, Department of Orthopedics, Southern California Permanente Medical Group, 6041 Cadillac Ave, Los Angeles, CA 90034 (dean.k.matsuda@kp.org).

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Avulsion fractures of the anteroinferior iliac spine apophyses are common injuries in athletic adolescent patients. The straight head of the rectus femoris has its origin at the anteroinferior iliac spine, and violent contraction of the rectus femoris musculature, particularly during explosive running, jumping, or kicking, may cause an avulsion fracture. Historically, these injuries have been treated nonoperatively with temporary relative rest and protected weight bearing, usually with crutches, until symptoms subside. However, the proximity of this apophysis to the anterosuperior acetabular rim and its inferior displacement with the aforementioned mechanism may not be benign. This article describes a case of a malunion of such a fracture, with subsequent symptomatic femoroacetabular impingement.

**Case Report**

A 13-year-old track athlete presented with a 4-month history of left deep groin pain with intermittent popping, mainly when sprinting off of starting blocks or jumping from a crouched position. The symptoms were nonresponsive to conservative treatment, including relative rest, avoidance of sprinting and hurdling, and nonsteroidal anti-inflammatory drugs (NSAIDs). He reported an injury 9 months previously when he was sprinting in football and was unable to continue playing for several weeks because of left proximal thigh pain with no mechanical symptoms. He was initially diagnosed with an adductor sprain, and radiographs were read as normal by his pediatrician and the radiologist. Relative rest and NSAIDs were prescribed. His pain resolved, and he returned to athletic endeavors for 3 months but then developed ipsilateral deep groin pain and mechanical symptoms.

Hip examination revealed a positive anterior impingement test reproducing his deep groin pain with internal rotation limited to 20°. His flexion abduction external rotation (FABER) test had mild pain and 8 cm of asymmetric decreased distance from the examination table to the lateral knee. Hip flexion strength was 4/5.

Review of the normal initial radiographs revealed an avulsion fracture of the anteroinferior iliac spine apophysis (Figure 1). Anteroposterior pelvis and Dunn lateral radiographs at referral (9 months later and also read by a radiologist as normal) revealed bilateral positive crossover and ischial spine signs. The distalmost extension of the left anteroinferior iliac spine malunion is significantly inferior to the level of the femoral head apex (red arrow).

Magnetic resonance arthrogram revealed a tear of the anterosuperior hip labrum and an osseous prominence that was visibly damaged labrum (asterisk). Abbreviations: AIIS, anteroinferior iliac spine; FH, femoral head.

The patient and his parents agreed to proceed with elective arthroscopic hip surgery. Supine hip arthroscopy was performed under general anesthesia, with intermittent hip distraction. Diagnostic examination revealed an unusual prominent bony protuberance at the anterosuperior rim, with adjacent fraying of the labrum (Figure 4). No discernable pseudarthrosis existed on arthroscopic probe manipulation. Some rectus femoris tendinous fibers were attached to this prominence.

**Figure 1:** Initial anteroposterior radiograph of the left hip obtained 2 days following initial football injury showing an avulsion fracture of the anteroinferior iliac spine apophysis with the most distal extent at the level of the apex of the femoral head (red arrow).

**Figure 2:** Anteroposterior pelvis radiograph 9 months after the initial injury showing bilateral positive crossover and ischial spine signs. The distalmost extension of the left anteroinferior iliac spine malunion is significantly inferior to the level of the femoral head apex (red arrow).

**Figure 3:** A detail of Figure 2 showing the anteroinferior iliac spine malunion and its most inferior extent (red arrow).

**Figure 4:** Supine arthroscopic photograph with a 70° arthroscope taken from the anterolateral portal. Note the proximity of the anteroinferior iliac spine malunion to the anterosuperior acetabular rim and the visibly damaged labrum (asterisk). Abbreviations: AIIS, anteroinferior iliac spine; FH, femoral head.
The fluoroscopic templating technique was used to accurately perform rim reduction and resection of the displaced and malunited anteroinferior iliac spine (Figure 5). Uneventful labral refixation was performed. Arthroscopic femoral osteoplasty with partial perichondral ring resection eliminated ongoing cam impingement on dynamic arthroscopic surveillance, extending proximally with some exposure of the physis at this level (Figure 6) to permit flexion to 120° in this track athlete. Repeat intraoperative anterior impingement testing confirmed 40° of unrestricted internal rotation.

Postoperatively, the patient used 2 crutches for 20-pound foot-flat weight-bearing ambulation for 2 weeks and began cycling on a raised-seat exercise bicycle on postoperative day 1. No intra- or postoperative complications occurred. Early postoperative radiographs revealed successful eradication of the malunion and anterosuperior overhang (Figure 7), whereas later radiographs demonstrated some heterotopic bone formation (Figure 8). At 18 months postoperatively, the patient had 5/5 hip flexor strength and no restriction in hip motion. He and his parents were pleased with his outcome. His self-assessed nonarthritic hip score improved from 22 preoperatively to 98 postoperatively, and he returned to football with no symptoms.

**Discussion**

Sprinter’s fracture or avulsion fracture of the anteroinferior iliac spine occurs in adolescents and adults. In adolescents, most often these are repetitive traction injuries causing anteroinferior iliac spine apophysitis, hypertrophy, or actual avulsion fractures most commonly seen in 14- to 23-year-old athletic patients. The rectus femoris is a diarthrodial muscle spanning the hip and knee. The straight head of the rectus femoris is responsible for the direct avulsion mechanism because it attaches to the proximal aspect of the anteroinferior iliac spine. Violent or explosive force with knee flexion and hip extension, as often occurs in kicking, has been proposed as a pathomechanism. Patients typically present with acute groin or thigh pain after such an injury, and radiographs are often diagnostic. The fact that our patient’s initial radiographs were misread is consistent with frequent cases of initial misdiagnosis.

The majority of patients respond to nonoperative treatment, typically involving a few weeks of protected ambulation on crutches and a gradual return to athletic activities after a few months. Surgery has been proposed for the minority of patients with displacement >2 cm, symptomatic nonunion, and bony hypertrophy. Surgical treatments have included open reduction and internal fixation with a cancellous screw and washer or cerclage wire and open resection. A congenital anomaly called a pelvic digit or iliac rib has been described in the region of the anteroinferior iliac spine and has been treated with open excision.

With the advent of femoroacetabular impingement, a single case was reported of an adult patient with a symptomatic traction hypertrophy of the anteroinferior iliac spine who underwent successful open resection. Our case differed because our patient was (1) an adolescent (2) with a radiographically confirmed anteroinferior iliac spine avulsion fracture (3) after a posttraumatic event with secondary femoroacetabular impingement (4) from a radiographically and arthroscopically confirmed malunion, which was treated successfully with (5) arthroscopic surgery. The history of an intermediate quiescent period with full return to athletics after the initial posttraumatic thigh pain followed months later by the onset of recalcitrant deep
anterior groin pain suggests that secondary femoroacetabular impingement from the anteroinferior iliac spine malunion was causative. The radiographic and arthroscopic findings and surgical outcome are also supportive. More recently, Larson et al\textsuperscript{15} reported 3 cases of extra-articular anteroinferior iliac spine or subspine impingement, although the causation (eg, avulsion fracture, traction apophysisis, anteroinferior iliac spine hypertrophy, or developmental) was not specified. According to Larson (oral communication, December 2011)\textsuperscript{15} The majority of anteroinferior iliac spine impingement cases are probably developmental. Their patients, of which 1 was an adolescent, also underwent arthroscopic resection, with encouraging short-term outcomes.\textsuperscript{15}

In contrast to open resection, the addition of arthroscopic spinoplasty to acetabuloplasty, labral refixation, and femoroplasty were therapeutic and less invasive. The initial postoperative radiographs showed recontouring of the acetabular rim, with eradication of the malunited anteroinferior iliac spine and anterosuperior overhang (Figure 7), but heterotopic bone formation (Figure 8) was present several months later. Anteroinferior iliac spine fractures have been associated with abundant ossification of the soft tissues to such a degree that these may be confused with osteosarcoma (differentiated by biopsy).\textsuperscript{16} Hence, a predisposition to heterotopic bone formation may exist in this anatomic region. We used standard prophylaxis with NSAIDs for 4 weeks as part of our postoperative protocol. Perhaps a prolonged period of NSAID prophylaxis or alternative protocols, such as radiation treatments, may be indicated. However, the oncogenic risks of the latter must be weighed against any potential benefit. Partial arthroscopic spinoplasty may have been sufficient to eradicate mechanical conflict, while stimulating less heterotopic bone formation. The distalmost extension of the heterotopic bone is much less than that of the anteroinferior iliac spine malunion, does not cause any symptoms or hip motion deficit, and follows the course of the rectus femoris tendon. Retention of hip flexion strength may be attributable to partial detachment of the broad origin of the rectus femoris direct head during arthroscopic spinoplasty.

With regard to adolescent femoroacetabular impingement, Philippon et al\textsuperscript{17} reported favorable outcomes after arthroscopic femoroacetabular impingement surgery. Femoroplasty in the face of an open capital physsis may theoretically cause growth disturbance or iatrogenic slipped capital femoral epiphysis; however, the judicious use of such a procedure may eradicate cam impingement while protecting the refixed labrum from early failure. We have performed arthroscopic femoroplasty with conservative partial takedown of the perichondral ring in several adolescent patients with no adverse outcomes, which concurs with early outcomes presented by O’Donnell.\textsuperscript{18} However, further investigation is needed to substantiate femoroplasty as a beneficial and safe intervention in the adolescent.

To our knowledge, this is the first documented case of acute anteroinferior iliac spine apophyseal avulsion fracture in an adolescent athlete causing secondary symptomatic femoroacetabular impingement from an inferiorly displaced malunion and its arthroscopic management. Surgical treatment, including arthroscopic spinoplasty, yielded a successful clinical outcome despite some nonrestrictive heterotopic ossification. Anteroinferior iliac spine avulsion fractures may merit a lower degree of tolerance for displacement in the acute setting and a higher degree of clinical and radiographic scrutiny with surgical intervention, possibly in the form of arthroscopic spinoplasty in the more chronic one.

\textbf{REFERENCES}


