

[Orthopaedic Surgery]

Subscapularis Strain From Swinging a Baseball Bat in an Adolescent With Closed Physis

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A healthy 16-year-old female baseball player was referred by her pediatrician for evaluation of pain in her right, dominant shoulder. The pain had begun insidiously 4 weeks previously after several sessions of batting practice and had worsened until she could not participate in baseball, even with low doses of ibuprofen. She was not participating in any other sports or weight lifting and had had no previous incidents of shoulder pain, but she did have a history of being able to voluntarily sublunate the right shoulder since she was a child. Her voluntary shoulder subluxation and reduction did not reproduce or worsen her pain. Results from her physical examination and radiographs were normal. Magnetic resonance imaging showed edema in the subscapularis muscle consistent with acute muscle strain. She was treated with 6 weeks of rest, ice, and anti-inflammatory medication as needed. She returned to baseball and hitting during the following 6 weeks with no limitations.

Keywords: rotator cuff; baseball; muscle strain; adolescent; subscapularis

Injuries to the upper extremity in pediatric and adolescent athletes are being seen more often with the expanded participation and higher competitive levels of youth sports.⁹ Nearly 6% of youth baseball participants seek medical attention for injuries sustained while participating in their sport.⁷ Most injuries are the result of overuse, and 26% involve the shoulder or upper arm.⁷ The most common lesion of the upper extremity in adolescents is an injury to the proximal humeral physis known as “Little League shoulder.” However, once the physes in the shoulder region are closed, the injuries sustained are more typical of those of an adult baseball player.¹⁵

Rotator cuff injuries in adolescents are rare: Fewer than 1% of rotator cuff tears occur in patients younger than 20 years.²⁰ Most such injuries in adolescents are traumatic lesser tuberosity avulsions.²⁰ For example, in 1 report, 4 athletic male adolescents (12-14 years old) sustained rotator cuff tears without lesser or greater tuberosity avulsion or fracture, but all involved traumatic events.²⁰ In another report, a subscapularis muscle strain was documented in a baseball player attempting to catch a fly ball.⁷

A review of the literature reveals a wide spectrum of possible injury to the subscapularis muscle, tendon, and lesser tuberosity in adolescent and young adult athletes.^{5,7,9,10,15,18,20}

CASE REPORT

The present patient gave consent and had written parental consent for information regarding her injury to be used in this case report.

A previously healthy 16-year-old girl who played baseball on a coeducational club-level baseball team each year was referred by her pediatrician for pain in her right, dominant shoulder. She batted and threw right-handed. Four weeks before presentation to the orthopaedic clinic, she had an insidious onset of right posterior shoulder pain after several sessions of indoor batting practice in preparation for the upcoming spring baseball season. She had had no previous problems with her shoulder but did have a history of voluntary anterior shoulder subluxations on her affected right side.¹⁴ She did not remember any single event while batting that bothered her shoulder, nor did she hear or feel any acute changes, such as a pop or snap in her shoulder. The patient was not involved in weight lifting or any other shoulder-stressing sports.

After the patient's first week of batting practice, her shoulder became extremely sore, and she applied ice and took some ibuprofen, which provided some temporary relief. When

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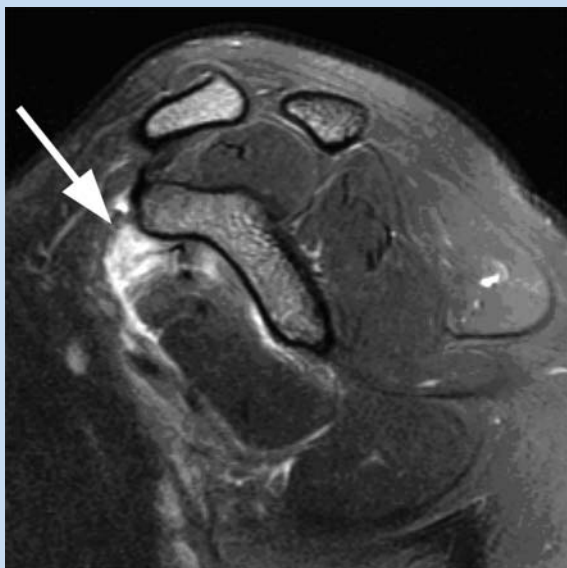


Figure 1. Coronal oblique fast spin-echo fat-suppressed T2-weighted image (TR = 3650 milliseconds, TE = 66 milliseconds) shows feather edema present in the upper half of the subscapularis near the myotendinous junction (arrow).

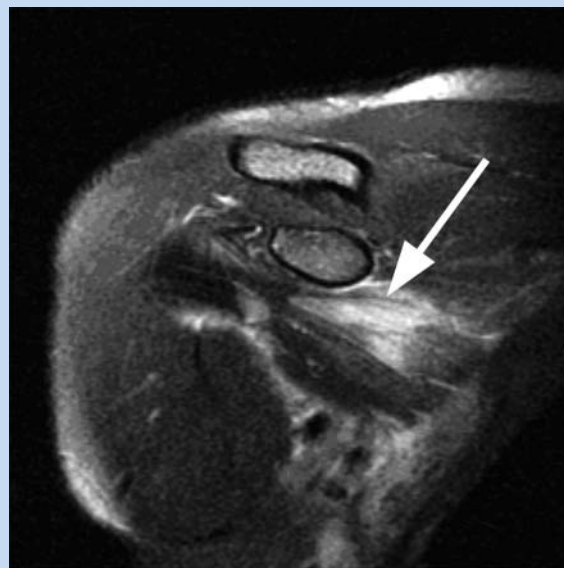


Figure 2. Sagittal oblique fast spin-echo fat-suppressed T2-weighted image (TR = 3650 milliseconds, TE = 66 milliseconds) shows partial discontinuity of the upper subscapularis muscle fibers (arrow).

her pain diminished slightly over the following week, she attempted to go back to playing baseball, but her shoulder pain increased with batting practice. She was then seen by her pediatrician and referred for an orthopaedic evaluation.

At that time (3 weeks after initial symptom onset), the patient indicated that her pain was mostly anterior, nonradiating, and not present at rest. She had no paresthesias, neck pain, or temperature/color changes in her extremity. She did not sense that her shoulder was subluxating with the hitting motion. She was otherwise in good health with no systemic illnesses. There was no family history of Marfan syndrome, Ehlers-Danlos syndrome, or other connective tissue disorders.

On examination, she did not show atrophy or deformity of her upper extremities, scapular winging, or dyskinesia. She had full range of motion bilaterally, which was symmetric in elevation. With the arms abducted 90°, she had external rotation of 95° and internal rotation of -10° on the right side—that is, 5° more external rotation and 10° less internal rotation than the contralateral side. Her strength, sensory, and reflex examinations yielded normal results. She was tender only over the anterior joint line and anterior proximal humerus.

She had a negative Neer sign,¹⁶ Hawkins-Kennedy impingement sign,⁶ Speed test,⁸ anterior apprehension sign, lift-off test,⁵ and belly-press test. During an active compression test with the thumb up, she localized pain to her posterior superior shoulder. She had a grade II sulcus sign in both shoulders, which was the same whether the arms were in neutral or external rotation. With her right shoulder, she could show a

voluntary anterior-inferior subluxation using her muscles, but this procedure did not reproduce her pain or symptoms.

Radiographs of her shoulder yielded normal results. Because a potential subscapularis or lesser tuberosity lesion was suspected, a magnetic resonance imaging scan had been obtained by her pediatrician before the referral. Coronal oblique fast spin-echo fat-suppressed T2-weighted images showed feather edema present in the upper third of the subscapularis near the myotendinous junction (Figure 1). Sagittal oblique fast spin-echo fat-suppressed T2-weighted images showed partial discontinuity of the upper subscapularis muscle fibers without involvement of the subscapularis tendon (Figure 2). These findings were consistent with a grade II strain (partial tear) of the subscapularis muscle.

The patient was treated nonoperatively with rest, ice, and use of nonsteroidal anti-inflammatory medications as needed for pain. It was recommended that the patient refrain from internal rotation and strengthening exercises until pain-free. She was allowed to return to baseball after 6 weeks, at which time she reported resolution of her symptoms.

The patient returned 18 months after her injury and stated that she was participating in sports without limitations. Physical examination results of her shoulder at that time were normal; she had no weakness in internal rotation nor increase in passive external rotation.

DISCUSSION

Subscapularis muscle strain should be considered in the differential diagnosis of baseball players with shoulder pain,

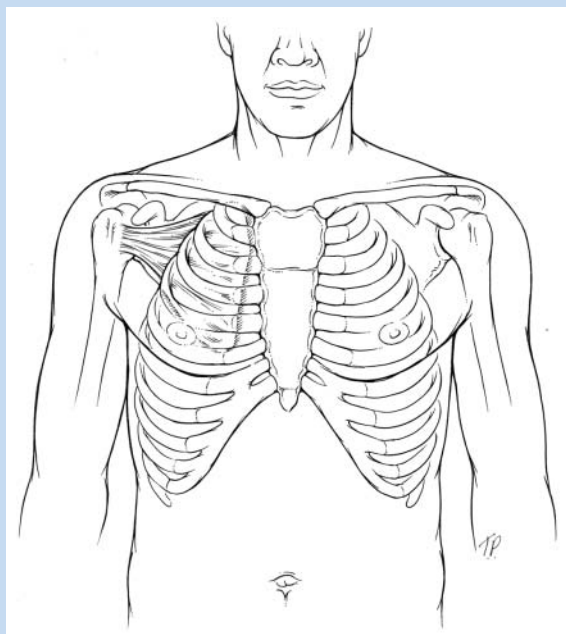


Figure 3. The subscapularis muscle fills the subscapularis fossa of the anterior side of the scapula.
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especially when that pain is experienced after batting. The mechanism by which the subscapularis is strained is unknown. Most muscle strains are believed to be a result of an eccentric contraction mechanism. When the batter is hitting right-handed, the right subscapularis muscle is expected to be maximally elongated with the bat in the cocked position. The subscapularis muscle decelerates the arm as it reaches an abducted and externally rotated position. When the arm is brought across the body into follow-through, the subscapularis muscle contracts concentrically, possibly causing muscle injury.

Some insight on the mechanism of this injury might be gleaned from the mechanism of injury of lesser tuberosity avulsions in adolescents. In traumatic cases, the mechanism of injury is forced abduction and external rotation.²⁰ In atraumatic cases, the mechanism of injury can be repetitive baseball throwing.^{10,18} Although the current patient was not throwing a baseball at the time of symptom onset, it is possible that repetitive abduction and extreme external rotation contributed to her muscle strain.

The subscapularis muscle is the primary internal rotator of the shoulder joint and the sole anterior component of the rotator cuff (Figure 3). As such, it acts as the major anterior dynamic stabilizer of the glenohumeral joint, counteracting forces capable of anteriorly displacing the humeral head out of contact with the glenoid cavity.^{1,3,7,8,11-13,19} Therefore, the batting motion may stress the subscapularis as it stabilizes the shoulder joint.



Figure 4. The lift-off test for the subscapularis muscle and tendon integrity is performed as shown.

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Muscle strain injuries can present with an episode of acute pain experienced during intense activity or as a result of accumulated strain on the muscle and myotendinous junction.¹⁷ Localized tenderness over the myotendinous junction, swelling, and ecchymosis may be evident on physical examination. Active and sometimes passive range of motion may also cause discomfort.¹⁷

Muscle strain of the subscapularis may be difficult to diagnose by physical examination because (1) the muscle is located deep in the anterior shoulder; (2) the sites of injury are not consistent, because of the multipennate architecture; and (3) there are few distinct features of injury to this muscle or tendon.⁷ Injuries of the subscapularis are usually present with pain when the arm is used overhead or below shoulder level, during increased external rotation, and with weakness of internal rotation.² Gerber and Krushell⁵ reported that 14 of 15 patients with subscapularis lesions had weakness to resisted internal rotation with the arm at the side. The current patient did not lack strength in internal rotation.

Two methods of assessing the subscapularis are the lift-off test (Figure 4) and belly-press test (Figure 5).^{2,5,20} A positive lift-off test occurs when the patient is unable to lift the dorsum off the hand of the lower back. The belly-press test was designed for patients unable to fully internally rotate the arm.⁴ A positive test occurs when the patient presses on the abdomen and the elbow does not move forward.¹³ Although both tests can be of benefit in evaluating patients with shoulder pain and rotator cuff abnormality, some authors have found that they are of limited value in patients with stiffness or loss of internal rotation.^{2,13}

The best imaging modality for muscle strain injury, if needed, is magnetic resonance imaging. T1-weighted images may show disruption of the normal architecture of the muscle-tendon



Figure 5. The belly-press test for the subscapularis muscle and tendon is an alternative test in patients who cannot internally rotate.

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junction. T2-weighted images will show increased signal in the injured muscle because of edema.¹⁷ The axial image provides the most advantageous view for evaluation of the subscapularis and biceps tendons. High-contrast axial plane images permit visualization of the anatomic course of the subscapularis tendon and its insertion into the lesser tuberosity.²

Initial treatment of subscapularis strain should aim at reducing the inflammatory response and consist of rest, ice, and use of nonsteroidal anti-inflammatory agents for relief of pain and swelling. The time frame for healing of muscle strain injuries is directly related to the severity of the injury (usually 2-8 weeks).^{9,17} With resolution of pain and swelling, the treatment emphasizes rehabilitation.

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