Overuse Injuries in Youth Sports: Is There Such a Thing as Too Much Sports?

Participation in youth athletics has dramatically increased over the past 2 decades despite the rise in childhood obesity. Approximately 45 million children 6 to 18 years participate in some form of organized athletics. Accompanying by the growing number of young athletes has come an increase in overuse injuries. Nearly half of all injuries evaluated in pediatric sports medicine are associated with overuse.

Overuse injuries are chronic injuries that occur with repetitive stress on the musculoskeletal system over the course of time without allowing adequate recovery. Pediatric athletes are prone to overuse injuries caused by stresses placed on growing bones. Extrinsic factors that contribute include inappropriate increases in training, hard training surfaces, or improper equipment. Intrinsic factors include decreased flexibility and muscle strength or extremity malalignment, such as excessive foot pronation.

Rachel Biber, MD; and Andrew Gregory, MD, FAAP, FACSM

1. Define and describe the pathophysiology of overuse injuries in young athletes.
2. Determine the most common sites of overuse injuries in young athletes.
3. Identify the most effective assessment and treatment methods for specific overuse injuries encountered in the pediatric athlete.

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Overuse injuries manifest in the pediatric athlete in a multitude of ways. This article reviews the most common overuse injuries in the young athlete, including apophysitis, tendinopathies, stress fractures, and patellofemoral pain.

CASE #1

A 12-year-old baseball pitcher comes to the office complaining of medial sided right elbow pain while pitching. He also plays third base while not pitching, and plays baseball 10 months out of the year. He reports that the pain has occurred over the past 3 weeks and has been gradual in onset. On examination of his elbow, he is tender to palpation directly over the medial epicondyle and has pain when valgus stress is applied to his elbow.

This case is a common illustration of a pediatric patient presenting with medial epicondylar apophysitis, otherwise referred to as “Little League elbow.” Apophysitis is common in children and adolescents because of periods of rapid growth. The apophysis is a bony prominence onto which muscles or tendons are attached. Apophysial closure parallels epiphyseal closure, making apophysial injury exclusive to growing individuals.

Definition and Pathophysiology

Apophysitis is caused by chronic traction of a tendon at its origin or insertion, which results in microavulsions at the bone-cartilage interface. The growth cartilage of the apophysis is the weak link in the muscle-tendon unit and is subject to injury from repetitive overload. Continuous tensile stress at any apophysial site leads to local swelling, pain, and even osteogenesis and callus formation. This pathophysiologic process can present as a painful lump, such as that which occurs at the tibial tubercle of the knee, or simply as pain with activity.

Sites

Common sites of apophysial injury are the knee (Osgood-Schlatter’s disease and Sinding-Larsen-Johansson syndrome), heel (Sever’s disease), medial epicondyle of the humerus (Little League elbow), and the tuberosity of the fifth metatarsal (Iselin’s disease) (see Table 1, page 288).

Diagnosis

Diagnosis of apophysitis is based on physical exam and history. The typical clinical presentation is the active child who complains of pain at the affected site that is worsened with activity. Exam reveals tenderness at the location of apophysial injury. Range of motion and strength are often normal, but pain can be elicited with stretching or strength testing of the muscle tendon unit.

Not all patients with the suspicion of apophysial injury need radiography because the diagnosis is clinical. However, X-ray changes can occur with apophysitis. Widening of the apophysis may be
Treatment of apophysitis is dependent on the site affected but generally includes conservative care because of the self-limiting nature of the disease.

Returning to our case, the baseball pitcher presented would benefit from activity modification with complete rest from all throwing (followed by gradual return to throwing as pain resolves), as well as core stabilization and scapular strengthening exercises.

Complete symptom resolution with apophysial injury usually occurs after fusion of the secondary ossification center at skeletal maturity. Regardless of the site of apophysial injury, the overarching principles of treatment consist of activity modification, direct icing of the area, short-term use of nonsteroidal anti-inflammatory drugs (NSAIDs) and physical therapy to improve flexibility and strength. Flexibility is aimed at the muscle-tendon unit attaching to the apophysis. Other specific considerations are dependent on the specific type of apophysitis (see Table 2).

CASE #2

A 14-year-old female basketball player presents to the office with right knee pain for approximately 1 month. She does not recall a specific injury and has not had any swelling of her knee. She has not improved with anti-inflammatory medication, and her play is limited because of the pain. On examination of her knee, she does not have an effusion, has point tenderness over her patellar tendon, and demonstrates decreased hamstring and quadriceps flexibility.

Definition

This 14-year-old girl demonstrates a typical presentation of a tendinopathy in the pediatric athlete, specifically patellar tendinitis. Tendinopathies are seen with less frequency in children in comparison with adults because the apophysis is weaker than the tendon itself. Therefore, with trauma, the epiphyseal plate, being weaker than the tendons and ligaments, is injured. Although apophysitis is a well-known overuse injury in the young athlete, tendon disorders can be encountered in this age group and are occurring with increasing frequency. However, most tendinopathies generally occur after skeletal maturity.

The nomenclature describing tendinopathies can be confusing. Tendinopathy is a general descriptor of tendon injury usually related to overuse. Tendinitis and tendinosis are two types of tendinopathies. Macroscopically, tendinitis involves symptomatic degeneration of the tendon with vascular disruption and an inflammatory repair response. In contrast, intratendinous degeneration (eg, microtears) without inflammation is evident with tendinosis.

Pathophysiology

Just as in apophysitis, overuse tendinopathies have a multifactorial origin while the pathophysiologic process leading to injury is not fully understood. Intrinsic and extrinsic factors interact in the basis of tendinopathies. Intrinsic factors that play a role include extremity malalignment and biomechanical faults. For
instance, hyperpronation of the foot has been associated with an increased prevalence of Achilles’ tendinopathy.6 Extrinsic causes of tendinopathies include inadequate equipment, inappropriate increase in training volumes, or insufficient rest from sport.

In athletes of all ages, vigorous and repetitive physical activity that leads to excessive loading of tendons is considered as the primary pathological cause of degeneration.7 The response to continued tendon overload is inflammation of the tendon and degeneration. Inflammation and degeneration can occur separately or in concert. If cumulative microtrauma persists without adequate rest from activity, then worsening degeneration or tendon rupture occurs.

Sites
Common sites of tendinopathies in the pediatric athlete include the rotator cuff in overhead athletes, the patellar tendon in running and jumping sports, and the iliopsoas in dancers. The ankle and iliotibial band are also frequent locations of tendinopathies in children (see Table 3).

Diagnosis
Making the diagnosis of a tendinopathy relies on history and physical exam. The patient will present with prolonged pain in the affected area, likely related to overuse and worsened with activity. X-rays can be useful to determine skeletal maturity but would not directly diagnose a tendinopathy. MRI can show changes within the tendon (increased fluid signal on T2 weighted sequences). Ultrasound can also show changes (appears as a hypoechoic area). Neither MRI nor ultrasound are necessary to make the clinical diagnosis, and findings may not be evident in symptomatic patients.

Treatment
The principles of management directed toward the patient presented in our case with patellar tendinitis are similar to the child presenting with apophyseal injury. She would most benefit from activity modification (relative rest from painful activities), stretching and strengthening of her quadriceps and hamstrings, icing, and anti-inflammatory medications. The addition of a stabilizing patellar tendon strap might also be helpful.

The nature of treatment for tendon injury in the pediatric athlete is conservative, with comparable treatment to apophyseal injury. Management is composed of correction of flexibility imbalances, improving strength, modification of training regimens, NSAID therapy, and icing of affected area. Other adjuncts to these therapies are dependent on the site of tendinopathy (see Table 4). Anti-inflammatory therapy is controversial, as types of tendinopathies may not be true inflammation; however, such therapy can be beneficial for pain. Prolotherapy, which involves injecting a non-pharmacological and non-active irritant into tendons or ligaments for the purpose of strengthening weakened connective tissue, has gained popularity of use in adults but has not been studied in children.

CASE #3
A 13-year-old male cross country runner comes to the office complaining of right foot pain while running. He has been running 5 miles per day, 6 days per week for the past month but was not able to run this summer. He reports that the pain began while running 2 weeks ago but was not associated with an injury. Despite new shoes, ice, and ibuprofen, he is no longer able to run. On examination of his foot, he has some mild swelling on the dorsum, which is tender to palpation over the second metatarsal. He walks on the lateral side of his foot and has pain with hopping on the right foot. Radiographs of the right foot are negative for a fracture line or callus.
**Definition**

This 13-year-old boy demonstrates a typical presentation of a stress fracture in the pediatric athlete, specifically the second metatarsal. Stress fractures are fatigue fractures of bone that develop as a result of the repetitive impact of running or jumping. Stress fractures are common in the lower extremity and are seen just as commonly in children as in adults.9 If the repetitive stress to the bone occurs faster than the bone’s ability to repair, then a stress fracture develops. Initially, there is edema in the bone, followed by microfractures, which then coalesce into a complete fracture.10

**Pathophysiology**

As with the other overuse injuries we have discussed, stress fractures have a multifactorial origin. Intrinsic and extrinsic factors contribute to the development of stress fractures. Intrinsic factors that play a role include extremity malalignment and bone health. For instance, the female athlete triad (oligomenorrhea, disordered eating, osteopenia) has been associated with increased stress fractures.11 Extrinsic causes of stress fractures include inadequate equipment, inappropriate increase in training volumes, or insufficient rest from sport.

In athletes of all ages, vigorous and repetitive physical activity that leads to excessive loading of bone and bone health are considered as the primary pathological causes of stress fractures.8 The response to continued bone overload is edema, followed by microfractures, followed by complete fracture. If the stress persists without adequate rest from activity, then malunion and degenerative arthritis can occur.

**Sites**

Common sites of stress fractures in the pediatric athlete are similar to those seen in the adult and include the metatarsals, tibia, fibula, and femur (see Table 5).

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**Table 5.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Site of Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip/pelvis</td>
<td>Femoral neck, pubic ramus</td>
</tr>
<tr>
<td>Thigh</td>
<td>Femoral shaft</td>
</tr>
<tr>
<td>Shin</td>
<td>Tibia, fibula</td>
</tr>
<tr>
<td>Foot/ankle</td>
<td>Metatarsals, calcaneus, cuboid</td>
</tr>
</tbody>
</table>

**Table 6.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Site of Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td>Femoral neck</td>
</tr>
<tr>
<td>Shin</td>
<td>Anterior tibia</td>
</tr>
<tr>
<td>Ankle</td>
<td>Medial maleolus</td>
</tr>
<tr>
<td>Foot</td>
<td>Tarsal navicular, base of the 5th metatarsal</td>
</tr>
</tbody>
</table>

**Diagnosis**

Making the diagnosis of a stress fracture relies on history and physical exam. The patient usually presents with focal pain in the affected area that is worse with activity or even walking. The hallmark on physical exam is point tenderness on the bone. Pain may also be elicited with a fulcrum test (bending the bone) or the single leg hop test. X-rays can be useful if a fracture or callus is visible, but may be normal in the first 3 to 4 weeks. Magnetic resonance imaging (MRI) is now the gold standard for diagnosis of stress fracture because it gives more anatomic information than bone scans with single-photon emission computed tomography (SPECT).11 MRI can show early changes in the bone (increased fluid signal on T2 weighted sequences) or a fracture line (linear signal on T1 weight sequences). MRI is not necessary to make the clinical diagnosis but may be very helpful in differentiating patients with fractures who do not heal well from those who do.

**Treatment**

The principles of management directed toward the patient presented in our case with a second metatarsal stress fracture would be to treat her pain and remove the offending activity. She would benefit from a walking boot, crutches if painful weight-bearing, activity modification (relative rest from impact activities), cross training, icing, and pain medicines.

The nature of treatment for stress fractures in the pediatric athlete is usually conservative. However, certain stress fractures do not have the capacity to heal with conservative measures and may require surgical management. Initial management for most stress fractures is composed of crutches, walking boot, modification of training regimens, acetaminophen, and icing of affected area. High-risk stress fracture should be referred for surgical consid-
eration (see Table 6, see page 290). Anti-inflammatory therapy is controversial, as it may actually interfere with fracture healing.

CASE #4
A 14-year-old volleyball player comes to the office complaining of bilateral anterior knee pain while playing. She is playing on her school team and a travel team and has been playing one to two times per day, 6 to 7 days per week for the past 2 months. She reports that the pain began after playing 2 months ago but was not associated with an injury. Despite knee braces, ice, and ibuprofen, she is having difficulty playing. On examination of her knees, she has no swelling, full motion, and is tender to palpation over the patellar facets. She has pain with the patellar grind test and tight quadriceps and hamstrings. She has a positive Trendelenberg test bilaterally. Radiographs of the knees are negative for effusion or lesion.

Definition
This 14-year-old girl demonstrates a typical presentation of patellofemoral pain syndrome in the pediatric athlete. Patellofemoral pain, also called anterior knee pain, is retropatellar pain without cartilage damage and must be differentiated from other causes of pain around the knee cap. The patella is a wedge-shaped sesamoid bone that acts as a fulcrum to transmit force across the knee joint. This force goes up significantly with activities, such as climbing stairs, squatting, running, and jumping. It is not known exactly where exactly the pain comes from. This pain is more common in female athletes.

Pathophysiology
As with the other overuse injuries we have discussed, patellofemoral pain is multifactorial in origin. Intrinsic and extrinsic factors contribute to the development of patellofemoral pain. Intrinsic factors that play a role include extremity malalignment (femoral anteverision, genu valgus, and foot pronation) and abnormalities of the patellofemoral joint. For instance, patella alta and baja have been associated with patellofemoral pain. Extrinsic causes of stress fractures include inadequate equipment, inappropriate increase in training volumes, or insufficient rest from sport.

In athletes of all ages, vigorous and repetitive physical activity that leads to excessive loading of the patellofemoral joint is considered the primary pathological cause of patellofemoral pain. The response to continued joint overload is pain. If the overactivity persists without adequate rest from activity, then worsening pain, articular cartilage damage, and degenerative arthritis can occur.

Sites
There are many common sites of anterior knee pain in the pediatric athlete and must be differentiated from patellofemoral pain (see Table 7).

Diagnosis
Making the diagnosis of patellofemoral pain syndrome relies entirely on history and physical exam. The patient usually presents with diffuse anterior pain that is worse with activity or even walking. The hallmark on physical exam is point tenderness on the patellar facets. Pain may also be elicited with the patellar grind test (compressing the patella). Exam should also include the hip and foot to check for contributing biomechanical factors. X-rays are rarely useful but may show a bipartite patella or other patellar anomalies. MRI is usually normal but may demonstrate articular cartilage changes in longstanding situations.

Treatment
The principles of management directed toward the patient presented in our case with patellofemoral pain syndrome would be to treat her pain and begin physical therapy. She may benefit from a knee sleeve, activity modification, cross training, icing, and pain medicines.

<table>
<thead>
<tr>
<th>Location</th>
<th>Site of Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Quadriceps tendonopathy</td>
</tr>
<tr>
<td>Retropellar</td>
<td>Patellofemoral pain syndrome</td>
</tr>
<tr>
<td>Superficial</td>
<td>Patellar tendonopathy, Sinding-Larsen-Johansson’s disease</td>
</tr>
<tr>
<td>Inferior</td>
<td>Osgood-Schlatter’s disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip flexion</td>
<td>Supine leg raises</td>
</tr>
<tr>
<td>Hip abduction</td>
<td>Lateral leg raises, clam shells, single leg supine bridges</td>
</tr>
<tr>
<td>Knee extension</td>
<td>Lunges, wall sits, leg press; squats and extension machines may aggravate pain</td>
</tr>
<tr>
<td>Knee flexion</td>
<td>Hamstring curls</td>
</tr>
</tbody>
</table>
The nature of treatment for patellofemoral pain in the pediatric athlete is usually conservative. Surgery is rarely successful for patellofemoral pain and may be counterproductive. Initial management for patellofemoral pain is comprised of physical therapy exercises (see Table 8, see page 291), knee sleeves, modification of training regimens, NSAIDs, acetaminophen, and icing of affected area. Patellofemoral pain should not be referred for surgical consideration.

CONCLUSION

Overuse injuries are common in pediatric athletes. We must be aware of the different types of overuse injuries because diagnosis affects treatment. The common thread among these injuries is overtraining, so education of athletes, parents, and coaches may prevent them from occurring. We have to teach them that adequate rest and recovery is an integral part of training.

REFERENCES