Sports Injuries

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Practice Gaps

1. Clinicians should be able to identify youth sports injuries predominantly by history.
2. Clinicians should be comfortable performing an appropriate physical examination in the evaluation of a youth sports injury.
3. Clinicians should be capable of ordering appropriate diagnostic tests in the evaluation of a youth sports injury.
4. Clinicians should be able to recommend a rehabilitation program and a return to play plan for a youth sports injury.
5. Clinicians should be aware of prevention strategies for youth sports injury.

Objectives

After completing this article, readers should be able to:

1. Describe the epidemiology and risk factors for pediatric sports injuries.
2. Conduct a focused history about a pediatric sports injury.
3. Perform a focused examination for a pediatric sports injury.
4. Order appropriate diagnostic testing for pediatric sports injuries.
5. Elucidate key points on evaluation to formulate a diagnosis for pediatric sports injuries.
6. Develop a treatment plan for pediatric sports injuries.

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ABBREVIATIONS

ACL	anterior cruciate ligament
CT	computed tomography
ED	emergency department
MRI	magnetic resonance imaging
OCD	osteochondral defect
OSD	Osgood-Schlatter disease
SCFE	slipped capital femoral epiphysis
SLJ	Sinding-Larsen-Johansson syndrome

It is well-known that daily physical activity supports a healthy lifestyle. One method for obtaining the recommended daily 60 minutes or more of vigorous physical activity for youth is sports participation, formal or informal.

Although the numbers have been increasing steadily over time, (1) approximately 60 million youth (age 6–18 years) are involved in some form of athletics (2) and approximately 44 million youth are in more than 1 sport. (2) In addition to the increased overall participation, the intensity of youth athletics has also increased. (1) Youth participants are younger than ever before, (1) and there are increased opportunities to participate in sports simultaneously. (1)(2) All of these issues have also created the opportunity for increased sports injuries in youth participants.

Approximately 2.6 million emergency department (ED) visits each year are attributed to sports injuries in individuals aged 5 to 24 years, with the greatest percentage found in boys 5 to 14 years old. (1) The sports most commonly associated with ED visits include football, basketball, soccer, and cycling. (1) The most common injuries diagnosed in the ED (~20%–30% each) include sprains, fractures, and contusions. (1) Fractures are twice as common in boys; upper extremity fractures are more common than lower extremity fractures. (1) In fact, forearm, wrist, and hand injuries account for approximately 30% to 35% of the injuries seen in the ED, and the foot and ankle compose 20%. (1)

Not all athletic injuries present acutely. Athletes can also present with overuse or chronic injuries due to repetitive stress to a certain anatomical area without adequate recovery over time. (1)(2) In concordance with acute injuries, overuse and chronic injures have also increased over time. (1) Overuse and chronic injuries can also be attributed to issues with technique, poor athlete mechanics (eg, inflexibility), improper or inadequate coaching, and unconditioned or unmaintained equipment and training areas. (1) In addition, with the decreasing age of participants has come an increase in early sports specialization, (2) which exacerbates the cycle of overuse and chronic injuries.

Current recommendations to prevent overuse and chronic injuries in youth sports participation include incorporating 1 to 2 days off per week and 2 to 3 months off per year. (2) It is also recommended that athletes delay sports specialization until late puberty. (2)

UNIQUENESS OF THE PEDIATRIC ATHLETE

Although youth and adults all have the same basic body components, there are certain aspects of the youth athlete that can make them vulnerable to musculoskeletal injury. Because they are still growing, youth athletes possess open growth plates, which, as the weak link in the musculoskeletal chain, can more easily sustain injury, leading to disturbances of the growth plates, the apophyses, and the joint surfaces. (1) Osteochondroses are the bone-cartilage disturbances that can occur in youth athletes. (3) Although they have no known cause, their occurrence is potentially related to anatomical issues, rapid growth, vascular disturbances, acute or chronic trauma, and hereditary factors. (3) Apophysitis is one type of osteochondrosis that occurs at the attachment of a tendon to a bone with a secondary ossification center (apophysis) that becomes inflamed/irritated, (3) usually from chronic pulling or traction.

With the increase in youth sports participation and the variety of acute and chronic injuries that youth athletes can sustain, a pediatric provider's understanding of youth sports injuries, from history to treatment and prevention, will help young athletes continue to participate safely and effectively from young ages into adulthood.

GENERAL EVALUATION

History

When a young athlete presents to the clinic with a musculoskeletal concern, taking a good history can help lead to an accurate diagnosis and, thus, an effective treatment plan. Although they are extremely resilient, youth athletes can present with complaints from head to toe. Despite the variety of locations of discomfort, the important questions to ask about the nature of their pain are relatively constant. For example, if a youth athlete presents with back pain, a provider first needs to determine the exact location of pain (have them point with 1 finger), its character, whether it is acute or chronic, how long the pain has been present, and the frequency and intensity of pain episodes. (4) A reason for the pain is also helpful, including a description of the injury or inciting event for acute pain or a change in activity or activity level for overuse or chronic pain. (4) A provider should also determine the effect of the pain on the athlete's regular activities and athletics and what makes the pain better or worse. (4)

Some athletes can struggle with describing the mechanism of injury, particularly if the injury happened quickly during an athletic event. With the advent of small video cameras and cell phone video, however, there is a possibility that the injury episode is on video. Video might also help highlight a gross mechanical or training issue that may be contributing to or resulting from the athlete's pain. A Formal Motion Analysis is required for an in-depth and detailed evaluation of an athlete's mechanics.

When seeing a young athlete in the clinic, it is also important to ask about treatments tried or provided to the athlete before arriving at the clinic. Did he or she visit an ED or urgent care center? Did he or she work with the certified athletic trainer at school? Has he or she already tried physical therapy or chiropractic care? Were any of these previous services helpful?

Because not all pain is from an injury, acute or chronic, remember that athletes are humans, too, and can develop other conditions that can contribute to musculoskeletal pain, including tumors, rheumatologic conditions, and infections. (4) On review of systems, remember to ask about night pain, fever, weight loss, and morning stiffness. (4)

Examination

The provider should begin the physical examination by taking the injured athlete's history and observing the athlete's body position and ease of movement, (4) which can provide additional clues to the area of injury and the associated functional changes. After the history is completed, the anatomical area(s) of concern should be unclothed for observation, noting symmetry with the unaffected side, swelling, deformity, or skin disturbance. When conducting the examination, it is always important to assess the joints above and below the painful area because the athlete's concern may involve referred pain. (2) In addition to the ease of motion, a provider should also assess the range of motion of the area of concern, (4) noting deficiencies and in what direction of motion. The static (ie, ligaments) and dynamic (ie, muscles) joint stabilizers should be tested, (2) which will also assess other less evident injuries to the area and functional changes. The neurovascular status of the area should also be evaluated by checking pulses and capillary refill. (2) In youth athletes, one should assume a physeal injury if there is tenderness to palpation over the growth plate, even if the radiographs are negative. (1)

Diagnostic Testing

The most commonly used diagnostic study in evaluating musculoskeletal injuries is the radiograph, which helps to rule in or out a bony abnormality. (2)(3) Providers should consider obtaining images of the contralateral side if ipsilateral images raise the question of there being an anatomical variant versus a clinically relevant radiologic difference. (2)(3) Because radiographs are in only 1 plane, at least 2 views should always be obtained, typically anteroposterior and lateral.

Management

Unless noted later herein, most sports injuries benefit from a period of rest. Absolute rest, if a fracture is assumed or confirmed, involves immobilization of the area so as to prevent use. Conversely, relative rest involves simple avoidance of the offending activity. A period of immobilization, in a splint, cast, or brace, can be helpful for pain control and stability. Treatment with anti-inflammatory medications or analgesics and cryotherapy (ie, ice) can also help with pain control and swelling. (1) If a fracture has been ruled out and pain has resolved, a period of rehabilitation (at home or with a physical therapist) and a gradual return to activity can begin. Therapy considerations include stretching and strengthening exercises of the involved and coordinating muscle groups. (1)(2)(3)(4)(5)(6)

SPECIFIC INJURIES

Although it is important to understand the general evaluation and management of pediatric sports injuries, specific injuries to individual joints can require unique evaluation and management considerations, as indicated in this section and the Table.

Knee

Whereas upper extremity injuries present with greater prominence to the ED, outpatient pediatric providers are typically confronted with youth athletes with knee pain, both acute and chronic.

Acute knee pain in youth athletes can commonly present as patellar injury or anterior cruciate ligament (ACL) tear. Patellar dislocations, or lateral movement of the patella outside the femoral groove, typically occur with the femur in internal rotation and the foot planted. As the athlete contracts his or her quadriceps, the patella is pulled laterally. This injury is more common in female athletes 14 to 18 years of age. After acquiring a history with the mechanism noted previously herein, the examiner will note tenderness to palpation around the patella, particularly medially, and a positive apprehension test, a maneuver during which the examiner tries to pull the patella laterally, causing the athlete to be anxious that the injury is about to recur. Radiographs may reveal bony abnormalities, especially osteochondral defects (OCDs), caused by the bone-sliding-over-bone mechanism of injury. Because additional injuries are possible with a patellar dislocation, if it is suspected by history or examination, a magnetic resonance imaging (MRI) study should be obtained. After reduction, which usually occurs spontaneously or is completed in the ED, the knee should be immobilized for 2 to 3 weeks, allowing for weightbearing as tolerated. Rehabilitation and gradual return to activity can begin thereafter. Surgical referral should be considered for those with recurrent dislocations (15%–44%) or with bony abnormalities (eg, OCD) on imaging. Unfortunately, patellar dislocations tend to be associated with a decline in sports participation. (1) A more common injury with a mechanism similar to patellar dislocation is a patellar subluxation, an injury during which the patella slides laterally in the femoral groove but remains in the space. Athletes with patellar subluxations can present with the same symptoms of patellar dislocation. Depending on the athlete's current status, management may be similar to that of a patellar dislocation if the patient is more severely affected; if less severe, management may be typical for musculoskeletal disorders, as noted previously herein, (1) with the addition of the use of a patellar stability brace to help maintain the patella in the femoral groove.

TABLE. Common Pediatric Sports Injuries

INJURY	AGE AND SEX	SPORTS	MECHANISM	HISTORY	TREATMENT	EXAMINATION	TESTS
Tibial tubercle apophysitis (Osgood-Schlatter disease) (1)(2)	11–15 y M > F	Running, jumping, pivoting/cutting	Traction	Typically no injury	Relative rest, ice, NSAIDs; PT/rehab Patellar tendon strap	Tenderness and swelling and prominence of tibial tubercle ± pain with resisted extension	Radiographs not needed
Sinding-Larsen-Johansson syndrome (distal patellar pole pain) (1)(2)	10–14 y M > F	Running, jumping, kicking	Traction	Typically no injury	Relative rest, ice, NSAIDs; PT/rehab Patellar tendon strap	Tenderness distal patellar pole, otherwise normal	Radiographs normal versus irregularity at distal patellar pole
Patellofemoral pain syndrome (1)	F > M	Athletics with increased load at patellofemoral joint (eg, running, jumping, climbing stairs)	NA	Typically no injury	PT/rehab Arch supports for excessive pronators	Mild peripatellar discomfort, + patellar grind, otherwise normal	Radiographs not needed
ACL (1)	≥11 y 3–7× F > M	Multiple	Pivot/twist or hyperextension on landing	Pop with pain and instant swelling, no weightbearing, feels "unstable"	Surgery	Effusion, + Lachman test	Radiographs MRI (definitive)
Patellar dislocation (1) and patellar subluxation	14–18 y F > M	Multiple	Quadriceps contraction on an internally rotated femur with a planted foot pulls patella laterally; dislocation typically reduces spontaneously	Same as mechanism	Reduction for dislocation knee immobilizer, PT/rehab, surgery if recurrent or bony abnormality	Tenderness in peripatellar area (especially medially), + apprehension test, –Lachman test (similar mechanism to ACL)	Radiographs ± MRI
Calcaneal apophysitis (Sever disease) (1)(2)(3)	8–13 y M > F	Ground impact sports; athletes in cleats and gymnasts	Traction versus compression	Heel pain (especially with activity) (3)	Relative rest, ice, NSAIDs; PT/rehab heel cups	Pain with calcaneal squeeze, tenderness at Achilles insertion, Achilles tightness, weak dorsiflexion	Radiographs normal ± fragmented apophysis
Lateral ankle sprain (1)	All	Jumping, pivoting, uneven ground	Inversion	Rolled ankle	RICE Immobilize if suspected growth plate injury PT/rehab	Swelling and tenderness over affected ligaments, decreased range of motion	Radiographs (if skeletal immaturity, or meets Ottawa Ankle Rules if not)

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TABLE. (Continued)

INJURY	AGE AND SEX	SPORTS	MECHANISM	HISTORY	TREATMENT	EXAMINATION	TESTS
Spondylolysis and spondylolisthesis (2)(4)	<16 y (spondylolisthesis)	Repetitive extension (throwers > rowers > gymnasts > weight lifters)	Repetitive spinal hyperextension	Low back pain ± radiate to buttocks or thighs, typically gradual, worse with extension and twisting, no neurologic symptoms	Relative rest PT/rehab Bracing is controversial spondylolisthesis > 50% or with neurologic symptoms or treatment failure, refer to orthopedics	Tight hamstrings, increased lumbar lordosis, + Stork test, ± tenderness in paraspinous area	Radiographs with AP, lateral, oblique views; oblique views with scotty dog sign with collar; ± MRI, single-photon emission CT or CT, bone scan
Low back strain (4)	All	All	Multiple	Typically acute	Relative rest Ice > heat massage NSAIDs Stretching	Negative straight leg raise (± back pain), normal neurologic examination	Radiographs if pain for ≥3 wk
Slipped capital femoral epiphysis (5)	11 y M > F Blacks > Hispanics > whites	All (obese)	NA	Hip, inguinal, thigh, or knee pain; limp ± pain	Immediate nonweightbearing surgical stabilization	External rotation at affected hip, antalgic gait, pain with/ limitation of internal rotation	Radiographs of pelvis (AP and frog leg)
Legg-Calve-Perthes disease (5)	4–8 y M > F	All	NA	Limp without pain; knee pain (referred)	Conservative Surgery at discretion of surgeon	Pain with internal rotation in abduction; preference for external rotation	Radiographs
Hip apophyseal injury (1)(2)	10–25 y	Running, jumping, kicking, pivoting, twisting sport (eg, soccer, football, gymnastics, hockey)	Traction	Pain and popping	Rest, ice, crutches PT/rehab, surgery for 2-cm displacement or if failed conservative management	Swelling, tenderness, pain with active use of associated muscle or passive stretch	Radiographs to evaluate fragment displacement and to assess healing
Proximal humeral epiphysiolitis (Little League shoulder) (2)(6)	11–16 y	Baseball pitchers	Traction (torque)	Pain, arm fatigue, decreased speed and accuracy, (2) may have increased throwing program recently	Rest from throwing PT/rehab, appropriate pitch counts and rest	Tenderness proximal humerus, pain with resisted external rotation, ± decreased motion	Radiographs ± widening of physis; radiographs should include axillary view and view with humerus at 30° of external rotation, compare opposite side

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TABLE. (Continued)

INJURY	AGE AND SEX	SPORTS	MECHANISM	HISTORY	TREATMENT	EXAMINATION	TESTS
Traumatic dislocation/ instability (shoulder) (1)(2)	Adolescents (males more likely to sustain recurrence)	Basketball, overhead throwing	Force applied with arm in abduction and external rotation	Same as mechanism	Immobilize initially PT/rehab to improve motion and strength surgery for athletes in contact sports	Shoulder asymmetry	Radiographs to evaluate fractures or other concomitant bony injuries
Multidirectional instability (shoulder) (1)	F > M	Gymnasts and swimmers	NA	Recurrent subluxation and spontaneous reduction	PT/rehab	Multiligament laxity	NA
Medial epicondyle apophysitis (Little League elbow) (1)(2)(6)	≤10 y	Throwing (especially pitching)	Traction versus avulsion	Pain worst at late cocking; decreased velocity/distance	Rest from throwing; PT/ rehab; surgical stabilization for >5-mm displacement; appropriate pitch counts and rest	Tenderness at medial epicondyle; pain with resisted wrist flexion and forearm pronation; pain with valgus stress	Radiographs (if mechanical symptoms, such as locking); compare opposite side
OCD (capitellum) (6)	> 10 y M > F	Throwers, gymnasts	Compression	Lateral elbow pain with throwing or weightbearing	Relative rest, surgery if unstable (ie, bony fragment or concern for dislodgment)	Decreased extension and supination/ pronation, effusion, potential mechanical signs/symptoms	Radiographs initially, although MRI demonstrates cartilage integrity/ surface
Distal radial epiphysitis (gymnast wrist) (2)	10–14 y	Gymnastics (especially, floor, beam, and horse)	Compression and shear	Participation in sport	Relative rest, ice, NSAIDs, wrist brace; PT/rehab	Normal motion, tenderness at distal radial physis	Radiographs with physeal widening

ACL=anterior cruciate ligament; AP=anteroposterior; CT=computed tomography; MRI=magnetic resonance imaging; NA=not available; NSAID=nonsteroidal anti-inflammatory drug; OCD=osteochondral defect; PT=physical therapy; rehab=rehabilitation; RICE=rest, ice, compression, and elevation.

With the increase in intensity of youth athletics, ACL tears are increasing in incidence. Their mechanism of injury mirrors, in part, that of patellar dislocation. Athletes will note pain and popping during a pivoting (ie, stop and twist) maneuver or with knee hyperextension on landing from a jump. Seventy percent of ACL tears are also accompanied by a meniscal tear; 46% occur with a cartilage injury. Tears of the ACL occur more commonly in those 11 years and older and in females (3–7 times) more than in males. (1) After the mechanism of injury noted previously herein, athletes will typically complain of immediate swelling, an inability to bear weight on the leg, and a feeling of instability. On examination they will have a large effusion and a positive Lachman test, (1) during which the knee is flexed to 20° to 30° and, with stabilization of the femur, the tibia is quickly pulled anteriorly to assess the ability of the ACL to stop the forward motion. A quick stop, or end point, signals that the ACL is intact; absence of the end point signals a concern that the ligament has been torn. Radiographs will demonstrate the effusion and may show medial tibial plateau injuries; however, the definitive test for an ACL tear is MRI. For athletes involved in pivoting sports, surgical intervention is necessary for ACL reconstruction. (1)

Figure. Patellar tendon strap placed above the tibial tubercle and below the patella.

Overuse and chronic knee injuries will also present to the pediatric clinic and typically involve the anterior knee. Chronic pulling on the tibial tubercle apophysis from the quadriceps via the patellar tendon can lead to tibial tubercle apophysitis, or Osgood-Schlatter disease (OSD). (1) Although it can occur in both knees, it is typically unilateral. (1) It occurs most commonly during periods of rapid growth (2) from 11 to 15 years of age. (1) Males are more commonly affected. (1)(2) Running, jumping, and pivoting, in other words sports that involve quadriceps contraction, can lead to or worsen this condition. (1)(2) Athletes in sports with these activities will often present with tenderness to palpation and swelling at the tibial tubercle, which may also be prominent on visualization. They may also experience pain with resisted extension (1) (ie, increasing the pulling forces on the tibial tubercle). Radiographs are not necessary to diagnose OSD alone. (2) Management is typical for musculoskeletal disorders, as noted previously herein, with the addition of the use of a patellar tendon strap to help offset the pulling forces on the tibial tubercle during athletics (Fig). (1)

Chronic pulling of the patellar tendon can also occur at its proximal attachment, resulting in distal patellar pole pain or Sinding-Larsen-Johansson syndrome (SLJ). (1) This syndrome occurs in slightly younger athletes (10–13 years of age) (1) and is more common in males. (2) Because it involves the same structures and a similar mechanism, commonly offending sports include those with running, jumping, and kicking. (1) On examination, athletes will have tenderness to palpation at the distal patellar pole. (1) Radiographs are often normal, but irregularity at the distal patellar pole can sometimes be seen. (2) Management is typical for musculoskeletal disorders, as noted previously herein, with the addition of the use of a patellar tendon strap to help offset the pulling forces during athletics. (1)

Patellofemoral pain syndrome is the name given to chronic anterior knee pain (1) that involves the mechanics of patellar motion in the femoral groove. Unlike OSD or SLJ, patellofemoral pain syndrome is more common in females, particularly in athletics that involve increased load at the patellofemoral joint; thus, running, jumping, and climbing stairs can all cause pain. Patellofemoral pain syndrome often occurs without injury or mechanical symptoms. On examination, athletes may experience mild peripatellar discomfort with palpation and present a positive patellar grind test, (1) during which the examiner slides the patella inferiorly toward the foot (with the knee in extension) and asks the athlete to contract the quadriceps muscle. A positive test will result in pain and a grinding sensation. (1) As referenced previously herein, when conducting the examination, it is always important to assess the joint above (ie, the hip for

the knee) because the athlete's concern may involve referred pain (2) from the hip and be due to a slipped capital femoral epiphysis (SCFE, detailed later herein). Management is typical for musculoskeletal disorders, as noted previously herein. Arch supports may be useful for athletes with excessive foot pronation. (1)

Foot and Ankle

As noted earlier, athletes often present for care for foot and ankle injuries. These injuries are the second most common reason for youth athlete acute visits to their primary care physician. (3)

Two of the most common complaints seen in the pediatric clinic include calcaneal apophysitis and lateral ankle sprain. Chronic pulling of the Achilles tendon on the calcaneal apophysis results in calcaneal apophysitis or Sever disease. (1)(3) Unlike OSD, calcaneal apophysitis is often bilateral. (3) Athletes with calcaneal apophysitis are often younger than those with OSD, ranging from 8 to 13 years of age. (1)(2)(3) Males are more commonly affected. Commonly associated sports are those with significant ground impact forces, (1) such as those experienced by cleated athletes and gymnasts. (2) In the clinic, athletes may report heel pain, particularly with weightbearing activity. (3) On examination they may experience pain with calcaneal squeeze (medial and lateral compression at the growth plate) (1)(2)(3) and tenderness to palpation at the Achilles insertion. (3) They may also have tight Achilles tendons and weak dorsiflexion strength. (3) Radiographs are often normal, but irregularity at the calcaneal apophysis can sometimes be seen. (2) Management is typical for musculoskeletal disorders, as noted previously herein, with the addition of the use of heel cups to provide cushion and to mitigate compressive forces with weightbearing. (1)(2)(3)

A lateral ankle sprain, a stretch or tear of one of the lateral ligaments in the ankle, most commonly results from an inversion injury. (1) Sports that facilitate this motion include those with jumping, pivoting, and running on uneven ground. The most commonly affected ligaments are the anterior talofibular ligament and the calcaneofibular ligament. (1) Athletes will often present saying they "rolled their ankle." They may also note swelling and a popping at the time of injury, as well as an inability to return to the game and bear weight on that foot. On examination they will display swelling and tenderness over the affected ligaments, as well as decreased range of motion. (1) Radiographs should be obtained if the athlete is still skeletally immature or if the athlete's condition meets the Ottawa Ankle Rules criteria. (1) According to the Ottawa Ankle Rules, radiographs should be obtained if there is inability to bear weight at the time of injury or at the initial medical evaluation and if there is pain or tenderness at any of the bony prominences of the ankle/foot (ie, the tip or posterior portion of either malleolus, the base of the fifth metatarsal, or the navicular bone). Management is typical for musculoskeletal disorders, as noted previously herein, except for initial immobilization if a growth plate injury is suspected based on physeal tenderness on examination (even with negative radiographic findings, a Salter-Harris I fracture could be present). (1) Reassessment with a physical examination and imaging at 3 weeks can either rule out or rule in a fracture at that time, (1) and definitive treatment with casting can begin or rehabilitation with exercises and bracing can be initiated.

Back

Back pain is another common problem for youth athletes, be it from a bony or muscular injury. Fifty percent of adolescent athletes can present to the clinic with back pain. (2)(4)

Athletes involved in sports with repetitive extension (eg, throwers, rowers, gymnasts, and weight lifters) can experience a fracture of the pars interarticularis (2)(4) or spondylolysis. A pars fracture can be unilateral or bilateral; however, if bilateral, the absence of connection can allow the upper vertebral body to slip forward on top of the lower vertebral body, a phenomenon called spondylolisthesis. (2)(4) The percentage of slippage is graded in quarters from 0% to 100%. (2)(4) Spondylolisthesis is more common in athletes younger than 16 years. (2) Athletes with either condition will present to the clinic with low back pain that may or may not radiate to the buttocks or thighs. (2) Their gradually developing pain is worse with extension and twisting motions. (4) They deny neurologic symptoms. (4) An examiner might note increased lumbar lordosis, tight hamstrings, tenderness to paraspinous palpation, and a positive stork test, (2) during which the athlete stands, raises 1 knee, and extends the back. Increased pain on the symptomatic side is positive. Radiographs should include oblique views (taken at an angle to the patient's right and left), which may demonstrate a scotty dog with a collar (ie, the fracture site). (2)(4) Additional imaging with MRI, computed tomography (CT), single-photon emission CT (SPECT), or bone scan may be warranted. (2)(4) Management is typical for musculoskeletal disorders, as noted previously herein; however, bracing can also be considered but is controversial at this time. (2) Patients with spondylolisthesis and greater than 50% slippage (ie, grade III or IV) or neurologic symptoms and patients with either spondylolysis or spondylolisthesis and treatment failure should be referred to orthopedics. (4)

Six percent of athletes may present with a low back strain. (4) Although it causes pain, it is still a benign condition, and

other, more concerning, diagnoses should be eliminated by history (as noted earlier) and physical examination. On examination athletes may note back pain; however, results of their straight leg raise should be negative and their neurologic examination normal. Radiographs should be obtained for athletes with pain lasting 3 weeks or longer. Management is typical for musculoskeletal disorders, as noted previously herein. (4)

Hip

Hip pain can occur in youth, be they athletes or not. In addition to a targeted history and physical examination, the age, sex, and health status of the athlete can help lead to the diagnosis.

Occurring in 10.8 per 100,000 children, the most common hip disorder in adolescents is SCFE, which occurs when the proximal femoral epiphysis slips posteriorly. (5) The incidence of SCFE hovers around age 11 years and is more common in males and in the black and Hispanic populations. (5) Although it can affect athletes in all sports, SCFE tends to occur in obese individuals, (5) so some sports may be more or less likely to have athletes presenting with SCFE. Affected athletes typically present with hip, inguinal, thigh, or knee pain and a limp. (5) On examination they tend to prefer keeping the affected hip in external rotation and have pain or limitation with internal rotation of that hip. (5) Because SCFE often occurs bilaterally, bilateral radiographs of the pelvis should be obtained and should include anteroposterior and frog leg views. (5) Management of SCFE varies from the typical musculoskeletal care that one would provide in the clinic. To prevent further injury to the joint, including avascular necrosis, cartilage damage, and later arthritis, these patients should be made nonweight-bearing immediately and referred for urgent, if not emergency, surgical stabilization. (5)

Younger boys, aged 4 to 8 years, may present with hip pain due to avascular necrosis of the femoral head, also known as Legg-Calve-Perthes disease. (5) They also present with limping and may not complain of hip pain; however, they may experience referred pain to the knee. (5) On examination they also prefer to keep the affected hip in external rotation and experience pain with internal rotation in abduction. (5) Radiographs may demonstrate variable femoral head irregularity. Once identified, the appropriate management is without consensus (5); however, orthopedic referral is still warranted. Conservative care aims to reduce pain, improve motion, and prevent progression of any deformity; surgical care is determined individually by the surgeon. (5)

Older athletes, aged 10 to 25 years, (5) may experience a traction or avulsion injury involving any of the several apophyses located about the pelvis, including the anterosuperior iliac spine (origin of the sartorius), anteroinferior iliac spine (origin of the rectus femoris), ischial tuberosity (origin of the hamstring), and iliac crest (attachment site of the tensor fascia latae and abdominal muscles). (2)(1)(5) Sports that commonly involve a pull at the hip are those that include running, jumping, kicking, pivoting, and twisting, such as soccer, football, gymnastics, and hockey. (5) Typically, athletes will experience a sudden contraction that pulls at 1 of the apophyses, followed by a popping sensation or sound and pain. (1)(5) On examination they may have swelling and tenderness to palpation in the affected area, as well as pain with active use or passive stretch of the muscle in question. (1)(5) Radiographs can be helpful to evaluate the avulsed fragment displacement degree and to assess healing. (1)(5) Management is typical for musculoskeletal disorders, as noted previously herein, (1)(2)(5) with the consideration for orthopedic referral for 2-cm fragment displacement or failed conservative management. (1)(5)

Shoulder

Youth athletes in sports with overhead arm motion can present to the clinic with shoulder pain, both acute and chronic. The shoulder is the most commonly dislocated joint in adolescents, be it an acute or chronic dislocation. (1) Acute dislocations typically occur when a force is applied to the arm while the shoulder is abducted and in external rotation. (1) For example, a basketball player attempting a desperation long-distance (Hail Mary) shot before the buzzer has the ball knocked out of his or her hand during late cocking and feels pain in the shoulder. On examination these athletes' shoulders will appear asymmetrical due to the humeral head's new and abnormal anatomical location. (1) Radiographs should be obtained to evaluate for bony injuries, including fractures. (1) Once reduced, the shoulder should be immobilized in a sling. (5) Management is typical for musculoskeletal disorders, as noted previously herein, (1) with the consideration for surgery for athletes in contact sports due to a 65% to 75% chance of recurrence, particularly in males younger than 20 years. (1)

Female athletes tend more commonly to have multidirectional shoulder instability, which is a chronic, atraumatic condition commonly found in gymnasts and swimmers. (1) They will typically note recurrent episodes of subluxation with spontaneous reduction. (1) On examination they will demonstrate shoulder laxity anterior, posterior, or inferior to the glenohumeral joint. (1) In the absence of trauma (ie, no concern for bony injury), radiographs are not indicated. Management is typical for musculoskeletal disorders, as noted previously herein. (1)

Frequent throwers can present with proximal humeral pain caused by traction on the proximal humeral physis

from the torque generated with throwing. (2)(6) Proximal humeral epiphysiolysis, or Little League shoulder, typically occurs in baseball pitchers aged 11 to 16 years. (2) In fact, one-third of baseball pitchers can experience shoulder or elbow pain, especially if throwing while fatigued or at higher velocities. (6) Athletes may present with shoulder pain, arm fatigue, decreased throwing speed or accuracy (2) and may report a recent increase in their throwing program. (6) It is important to query their throwing history: the amounts and frequencies of throwing events, participation on 1 or more than 1 team, and participation throughout the year or intermittently. (6) On examination, these athletes have tenderness to palpation at the proximal humerus, may have decreased shoulder motion, and note pain with resisted external rotation. (2)(6) Radiographs may demonstrate widening of the proximal humeral physis (2) and should include axillary views and anteroposterior views with the shoulder in neutral and in external rotation. (6) Imaging the opposite side can be helpful in the diagnosis. (6) Management is typical for musculoskeletal disorders, as noted previously herein, (2)(6) except for an initial, significant period of rest from throwing consisting of 6 weeks up to 3 months. (6) Various sports organizations, leagues, and medical organizations have posted recommendations for pitch counts and rest periods that adjust with age, (6) which can be helpful in counseling athletes and families in beginning or returning to baseball.

Elbow

The shoulder is not the only joint involved in throwing mechanics. Throwers also may present with elbow pain, medial and lateral.

When the flexor and pronator muscles of the forearm resist the valgus load associated with late cocking in throwing they generate a pull on the medial epicondyle. (1)(6) Some athletes may experience a sudden forceful throwing event, causing an avulsion of the medial epicondyle apophysis. (6) When the pulling is recurrent or becomes chronic, medial epicondyle apophysitis, or Little League elbow, can result. Commonly seen in those 10 years and younger, (1) baseball pitchers are most affected by Little League elbow. (6) Outside of a sudden avulsion injury, athletes with overuse or chronic pain will present with pain that is worst at late cocking. (6) As with Little League shoulder, they will also complain about their throwing ability, noting decreased velocity and distance. (6) They will have tenderness to palpation at the medial epicondyle (1)(2)(6) and experience pain with resisted wrist flexion and forearm pronation and with a valgus stress test. (2) Radiographs, with comparison views of the opposite side, should be considered, particularly if there are mechanical symptoms, such as locking. (6) Management is typical for musculoskeletal disorders, as noted previously herein, (2)(6) except for an initial, significant period of rest from throwing until pain free (1)(2)(6) and consideration of referral to orthopedics for surgical stabilization for avulsions that are displaced 5 mm or more. (6)

Although some athletes may experience medial elbow pain from pulling forces, others may experience lateral pain from compression forces, resulting in an OCD of the lateral capitellum. (6) These athletes tend to be older than 10 years and male, throwers and gymnasts. (6) They will present with lateral elbow pain with throwing or weightbearing and may demonstrate decreased extension, supination, and pronation (always compare with the unaffected side). (6) The examiner may note an effusion and mechanical signs, as well. (6) Although radiographs should be performed initially, an MRI most effectively demonstrates the cartilage surface and integrity. (6) Management is typical for musculoskeletal disorders, as noted previously herein, (6) except for consideration of referral to orthopedics for surgical stabilization if bony fragments are present. (6)

Wrist

As noted previously herein, upper extremity fractures are commonly seen in the ED. In the clinic, athletes may present with more chronic concerns. Fifty percent to 80% of gymnasts may sustain wrist injuries. With weightbearing on their upper extremities, gymnasts can sustain significant compression on and shear stress of the distal radial physis, resulting in distal radial epiphysitis, or gymnast's wrist. (2) Commonly seen in prepubertal athletes (aged 10–14 years), a gymnast's wrist is often associated with floor, beam, and horse activities. (2) On examination, athletes may display normal motion and experience tenderness to palpation of the distal radial physis. (2) Radiographs may demonstrate widening of the growth plate (2). Management is typical for musculoskeletal disorders, as noted previously herein, (2) except for the addition of a wrist brace as needed. (2)

CONCLUSION

As young athletes continue to increase their frequency and intensity of sports participation, so will their risk of injury increase. They will present to the ED but also to their primary care provider. Evaluation and management of common sports injuries in youth requires knowledge of the likelihood of injury in that age group, from prepubertal to young adult, or sex; the types of injuries associated with

different sports; common mechanisms of injury that lead to young athlete pain; the anatomy of the area of concern; helpful historical and physical examination findings; and the appropriate diagnostic tests and therapeutic interventions, based on all of the above.

Summary

- Based primarily on consensus, owing to lack of relevant clinical studies, important historical findings to note in evaluating a pediatric musculoskeletal injury include confirming the location of the pain and the mechanism of injury, as well as performing a review of systems to rule out medical or rheumatologic causes of musculoskeletal pain.
- Based primarily on consensus, owing to lack of relevant clinical studies, important examination findings to note in evaluating a pediatric musculoskeletal injury include inspection of the area of concern at rest and with motion, as well as evaluating the ligament and muscle function of the affected area.
- Based primarily on consensus, owing to lack of relevant clinical studies, important considerations in ordering diagnostic testing to evaluate a pediatric musculoskeletal injury include obtaining radiographs with at least 2 perpendicular views to rule in/out bony abnormalities and loss of function.
- Based primarily on consensus, owing to lack of relevant clinical studies, important considerations in treating a pediatric musculoskeletal injury include setting a period of rest that allows for appropriate healing; prescribing orthotic devices to aid in pain control, movement, or recovery; prescribing a rehabilitation program for home or at a physical therapy center; and determining return to activities when the athlete has resumed full function of the affected area.
- Based primarily on consensus, owing to lack of relevant clinical studies, important considerations in referring to orthopedics for a pediatric musculoskeletal injury include significant structural or functional disability and failure of conservative management.

SUGGESTED QUALITY IMPROVEMENT PROJECTS

- Using a template to obtain an appropriate history and physical examination in evaluating a pediatric sports injury
- Creating decision support to order appropriate diagnostic testing in evaluating a pediatric sports injury

ADDITIONAL RESOURCES

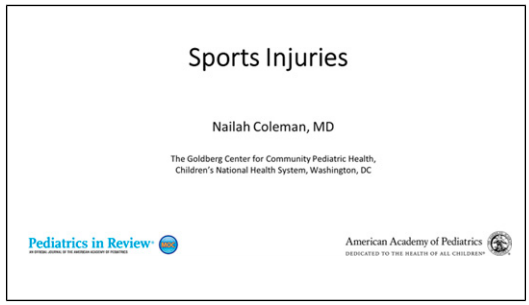
For families:

- American Orthopaedic Society for Sports Medicine Stop Sports Injuries: https://www.stopsportsinjuries.org
- US baseball pitch counts: http://m.mlb.com/pitchsmart/pitching-guidelines/

For providers:

- Physical examination how-to videos by Dr. Jordan Metzl: http://drjordanmetzl.com/pediatric-exams/
- Team Physician Consensus Statements: https://journals.lww.com/acsm-msse/pages/collectiondetails.aspx?TopicalCollectionId=3

***To view teaching slides that accompany this article, visit* http://pedsinreview.aappublications.org/content/40/6/278.**



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1. A 14-year-old girl is brought to the office after sustaining a twisting left knee injury while playing soccer. She is unable to bear weight and says that her knee feels unstable. She walks into the office with crutches. Physical examination of the left knee is significant for a large effusion and a positive Lachman test. An anterior cruciate ligament tear with or without meniscus involvement is suspected. In addition to placing her in a knee immobilizer, which of the following is the most appropriate next step in management?
    A. Continue to use the crutches and reevaluate in a few weeks, after the effusion is resolved.
    B. Order radiographs and magnetic resonance images of the knee and refer her to orthopedics.
    C. Prescribe nonsteroidal anti-inflammatory drugs (NSAIDs) for 2 weeks.
    D. Refer her to physical therapy.
    E. Refer her to the emergency department for further evaluation.
2. A 12-year-old boy who runs track is brought to the clinic for evaluation of left knee pain. He has been complaining of left knee pain on the anterior tibia area below the patella. There is no swelling of the left knee or effusion. A swelling in the area of the anterior tibia directly below the left patella is noted. Which of the following is the most likely diagnosis of the left lower extremity in this patient?
    A. Anterior cruciate ligament tear.
    B. Patellar dislocation.
    C. Patellofemoral pain syndrome.
    D. Sinding-Larsen-Johansson syndrome.
    E. Tibial tubercle apophysitis.
3. A 9-year-old boy who is a gymnast is brought to the clinic for evaluation of heel pain. The patient complains of bilateral heel pain, particularly when he lands on his feet during gym practice. He denies any recent trauma. On physical examination he has point tenderness around the midfoot area and pain with calcaneal squeeze bilaterally. No ankle swelling is noted. Which of the following is the most likely diagnosis in this patient?
    A. Hypermobility syndrome.
    B. Lateral ankle sprain.
    C. Pes planus or flat feet.
    D. Sever disease or calcaneal apophysitis.
    E. Shin splints.
4. An overweight teenage female athlete is seen in the clinic because of low back pain. The patient participates in weight lifting. She reports on and off nonradiating lower back pain exacerbated by exercise and relieved by rest. There is no history of change in bowel habits and no urinary retention. On physical examination she does not have any midline back point tenderness and has normal neurologic examination findings, with no pain on straight leg raise. Radiographs of the lumbar spine are normal. The patient was recommended rest, ice, and NSAIDs. In addition to discussion about weight management, which of the following is the most appropriate next step in the management in this patient?
    A. Complete bed rest.
    B. Magnetic resonance imaging of the lumbar spine.
    C. Myelogram.
    D. Putting her in a back brace.
    E. Reassessment in 3 weeks and possible physical therapy.

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5. A 13-year-old overweight boy is seen in the clinic with a history of intermittent bilateral hip pain, worsening during the last 4 weeks. The pain is exacerbated by running, and sometimes he feels that his legs will give away. This has affected his sports participation. He has limited internal rotation of both hips. Which of the following is the most likely diagnosis in this patient?

   A. Back injury leading to referred pain to the hip.
   B. Bilateral avulsion injury of the anterosuperior iliac spine.
   C. Bilateral femoral anteversion.
   D. Bilateral slipped capital femoral epiphysis.
   E. Legg-Calves-Perthes disease.

Sports Injuries

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