Sports Medicine

A Parent's Guide to Knee Injuries

NATIONWIDE CHILDREN'S®

Understanding Knee Injuries in Adolescent Athletes

The popularity of youth sports is continually rising with over 25 million children and teens now participating in scholastic sports, and an additional 20 million in community-based youth sports organizations. With increased participation comes an increase in sports-related injuries. The knee is one of the most commonly injured joints, with an estimated 2.5 million sports-related knee injuries occurring each year in adolescents.

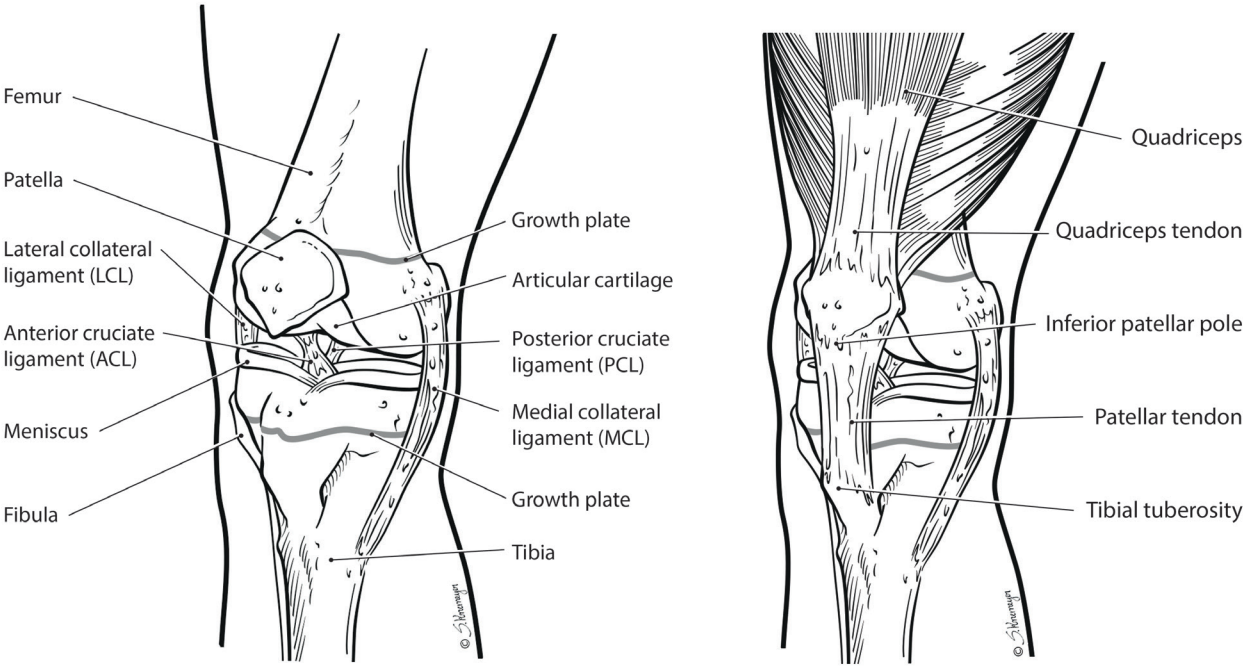
Furthermore, up to 60 percent of sports-related surgeries in high school athletes are on the knee. This may be because the knee joint is so complex. It must provide a combination of stability and mobility, while also supporting the athlete's body weight, so there are unique stresses placed upon it during sports-related activities.

For people under the age of 25, sports and recreational activities are the most common cause of knee injuries. More specifically, sports-related knee injuries can have either acute – resulting from a specific, traumatic event – or chronic, on-going causes. Common acute injuries are ligament tears and meniscus tears. (In contrast to acute injuries, chronic injuries develop gradually over time.)

Children and adolescent athletes have different injury patterns than adults and require specialized evaluation and treatment. For instance, children and adolescents have open growth plates that can result in unique injuries. In particular, growth plate fractures, known as Salter-Harris fractures, need to be seen by the kind of specially trained medical professionals you'll find at Nationwide Children's Hospital Sports Medicine.

Anatomy of the Knee

The knee is a complex joint comprised of bones, cartilage, ligaments and muscles. All of these structures work together to provide stability and mobility.



Bones
The knee joint is made up of four bones – the femur (thighbone), the tibia and fibula (lower leg bones) and the patella (kneecap). The tibia and the femur articulate (fit together) at the knee joint line. The patella is enveloped by the tendon of the quadriceps (thigh) muscle and moves within the groove of the bottom of the thighbone. This allows the quadriceps muscles to straighten the knee more easily. The top of the fibula meets outside the tibia, below the joint line.

Cartilage
There are two half-moon-shaped cartilage structures between the tibia and femur called the medial and lateral meniscus. The menisci provide stabilization, cushioning and friction reduction at the knee joint.

Ligaments
A ligament is a rope-like structure that connects two bones. The major stabilizing ligaments of the knee include the anterior and posterior cruciate ligaments (ACL & PCL) and the medial and lateral collateral ligaments (MCL & LCL). The ACL attaches the front of the tibia to the femur. The PCL attaches the back of the tibia to the femur. The ACL and PCL help prevent the knee from twisting. The MCL attaches the femur to the tibia on the inside of the knee. The LCL attaches the femur to the fibula on the outside of the knee. The MCL and LCL provide support from side-to-side and rotational forces.

A ligament injury is called a sprain. Sprains are classified into three grades. In a *first-degree sprain* the ligament is not lengthened (stretched), but is painful. A *second-degree sprain* consists of a lengthened and/or partially torn ligament, but it still helps maintain the relationship between the two bones. A *third-degree sprain* is when the ligament is completely torn. This means it no longer helps hold the two bones together.

Muscles
There are several groups of muscles that act on the knee joint and work together in a very complex manner. The quadriceps (thigh) muscles are primarily responsible for straightening the knee. The quadriceps muscles come together to form the patellar tendon that connects on the front of the tibia. The hamstring muscles and calf muscles are primarily responsible for bending the knee.

Risk of Traumatic Knee Injuries

The risk of an ACL or MCL tear is higher in contact sports, such as football or rugby, and in sports requiring pivoting, jumping, cutting or changing direction, such as basketball, soccer and volleyball. Poor strength, flexibility, balance and core control, as well as improper equipment, can also increase the risk for injury. Strength and flexibility should be equal on the front (quadriceps) and back (hamstrings) of the thigh. If there is an imbalance of strength or flexibility, the knee is at greater risk for injury.

Anterior Cruciate Ligament (ACL)

ACL tears mostly occur in non-contact situations, particularly pivoting and landing, but can result from contact as well. Up to 70 percent of youth with an ACL tear will also injure their meniscus.

Females are at greater risk for ACL tears for several reasons. They have wider hips, which create a larger angle between the knees and the hips (known as the Q-angle). The greater the Q-angle the athlete has, the more stress she places on her ACL and the more at risk she is for injury. Females are also more likely to land from a jump with a straight leg. When landing this way, some females tend to allow their knees to move inward instead of staying inline above their toes, putting more stress on the ACL. Females have also been shown to use their quadriceps more than their hamstrings, which may predispose them to these injuries.

Signs and Symptoms of an ACL Tear
ACL injuries can be caused by a direct blow, but are more commonly a result of a non-contact injury when twisting, cutting or landing awkwardly. Hearing or feeling a "pop" at the time of the injury may be an indication of an ACL tear. Significant swelling around the knee is typical and can appear within hours after injury. Classic symptoms are "giving out" or buckling. This may be experienced with simple activities like walking and using stairs, or more advanced activities within a sport. Occasionally, being unable to straighten or bend the knee all the way, known as locking, may occur when there is also an injury to the meniscus, which commonly accompanies ACL tears.

Expected Outcome
Typically, surgery is required for a torn ACL due to the ligament's inability to heal on its own. After surgery, rehabilitation is required to regain range of motion and strength. With the proper management, most athletes are able to return to complete physical activity within about six months, but may require the use of an ACL brace.

Medial Collateral Ligament (MCL)

The MCL is the most commonly injured ligament in sports. Most MCL sprains occur when a direct blow occurs to the outside of the knee, causing stress to the inside of the knee. Sometimes these injuries can also occur without contact, for example, when cutting awkwardly.

Signs and Symptoms of an MCL Sprain
Tenderness and pain on the inside part of the knee may suggest an MCL injury. Hearing or feeling a popping or tearing sensation along the inside part of the knee at the time of injury, or swelling/bruising that occurs within 24 hours of injury may also be noted. MCL sprains can cause limping, stiffness or decreased range of motion.

Expected Outcome
The MCL usually heals on its own with appropriate treatment. This typically consists of bracing for several weeks or months depending on the severity of the injury. Rehabilitation focuses on strengthening the muscles around the ligament and regaining the knee's range. Grade I and II injuries can often return within 2-4 weeks, while grade III injuries often require 6-12 weeks.

Meniscus Tear

A meniscus tear most frequently occurs when twisting or pivoting while running or jumping, or from a direct blow to the knee. The inner (medial) meniscus is injured more often than the outer (lateral) meniscus because it is less mobile.

Signs and Symptoms of a Meniscus Tear
As with an ACL tear, a pop is often heard or felt at the time of injury. Swelling usually occurs soon after. Pain at the joint line, where the two bones meet, can indicate a meniscal injury. Squatting on the affected knee causes pain and patients are often unable to fully bend the knee. Other classic symptoms of meniscal tears include not being able to bend or straighten the knee all the way or feeling something catch in the knee during movement. Using stairs while having a meniscal tear can be very painful.

Expected Outcome
In the adolescent athlete, surgery is almost always required for these injuries. If the tear occurs in a portion of the meniscus with good blood supply, surgeons may try to sew the meniscus together (repair). If the tear occurs in an area of poor blood supply, this part of the meniscus will likely be taken out (resected). Resection typically allows for faster return to play (4-6 weeks) but can decrease the stability of the knee, leading to more long-term complications. Repairing the meniscus leads to a longer recovery time (3-4 months), but may provide a better long-term outcome. The doctor, along with the patient and their family, must decide which treatment is best. Rehabilitation is common after either type of surgery.

Patellar Dislocation and Subluxation

The kneecap (patella) sits in the groove of the thighbone (femur). If the kneecap becomes displaced from this groove, it can be very painful. When the kneecap comes part way out of the groove then returns on its own, it is called a subluxation. When the kneecap displaces all the way and remains out of the groove, this is referred to as a dislocation. This injury typically occurs as a result of a direct blow to the knee, a twisting/pivoting motion of the leg, or a powerful muscle contraction of the quadriceps. Some individuals are more susceptible to subluxations or dislocations because of the looseness of their ligaments.

Signs and Symptoms of Patella Dislocation or Subluxation
Most athletes can tell when their patella comes out of place. The patella almost always dislocates to the outer (lateral) side of the knee causing an obvious deformity. Sometimes it goes back into place by itself when the knee is straightened, but other times it may have to be put back in place by a medical professional. Tenderness, swelling and/or bruising around the front of the knee are common after these injuries, along with pain when attempting to move the knee and a feeling that the knee may give out when supporting their body weight.

Expected Outcome
Complete healing of uncomplicated subluxations/dislocations can occur in as little as 6-8 weeks with appropriate treatment. Initial management usually consists of some period of immobilization or bracing, depending on the severity of the injury. Rehabilitation for range of motion and strength are usually required. Bracing may decrease risk of future dislocations or subluxations. Returning to activity too soon or without proper rehabilitation may predispose the athlete to frequent or recurrent injury. Surgery may be required if a piece of bone or cartilage is chipped off during the injury or if episodes of instability occur repeatedly.

Overuse Knee Injuries

Chronic and overuse injuries make up about half of the sports-related injuries that are seen in sports medicine clinics in the United States. In children and adolescents, chronic knee injuries are commonly related to repetitive, sub-maximal loading of tissues and repeated trauma, but may also be related to growth-related disorders.

Health care professionals have identified factors, such as improper exercise technique and training errors, inadequate rest, faulty movement patterns, muscle imbalances and the increased prevalence of sport specialization as common causes of overuse injury. Fortunately, most of these factors are modifiable, which means that many of these conditions may be prevented through education of coaches and parents, properly designed training programs, and participating in multiple sports instead of focusing on just one.

Patellar Tendonitis (Jumpers Knee)

Patellar tendonitis involves pain and inflammation of the patellar tendon, located in the front of the knee. It connects the quadriceps muscle and patella (kneecap) to the tibia. Overuse of the quadriceps muscle and the patellar tendon cause this injury. A sudden increase in the amount or intensity of activity can also lead to patellar tendonitis. Occasionally, a direct blow to the knee may cause this injury.

Symptoms of Patellar Tendonitis
The tendon may be tender, swollen, warm and/or red. Tenderness is usually noted at the middle of the tendon between the bottom of the patella and the tibial tuberosity. Pain is most often felt during running and jumping, while standing from a seated position, or when bending the knee completely (squatting or kneeling).

Expected Outcome
A combination of activity modification, ice and anti-inflammatory medicine usually leads to a rapid improvement of symptoms. The treatment plan should also include stretching and strengthening of the muscles of the lower extremity, along with core strengthening. A brace or strap may sometimes be helpful, as well.

Osgood Schlatter Disease (OSD)

OSD is inflammation of the tibial tubercle growth plate, which is the site of attachment of the patellar tendon in the front of the knee. In general, growth plates are more susceptible to injury than other parts of the body because they are softer and weaker than the rest of the bone. A rapid increase in physical activity, decreased strength and poor flexibility are all risk factors for this problem. Adolescents are prone to OSD because they can grow quickly in a short amount of time and that leads to muscle tightness and increased stress on the growth plate. Boys age 11-16 are at the greatest risk for OSD, but this condition is being seen with increasing frequency in girls.

Symptoms of OSD
A tender, sometimes swollen bump below the knee indicates OSD. Running, jumping, squatting, kneeling and climbing stairs typically aggravate the pain.

Expected Outcome
This condition is temporary and typically goes away once this growth plate closes in mid-late adolescence. Mild cases may require only slight modification of activity. Decreasing activities (jumping, deep knee bends, weight lifting) that put stress on the injured area is important for recovery. Icing after activity and taking anti-inflammatory medicine as needed may be helpful. The treatment plan should also include stretching and strengthening of the muscles of the lower extremity, along with core strengthening. A brace or strap may sometimes be needed. More severe cases may require complete cessation of activity, along with a brief period of immobilization and formal rehabilitation.

Sinding-Larsen-Johansson Syndrome (SLJ)

Similar to OSD, Sinding-Larsen-Johansson syndrome is an overuse injury that is caused by inflammation at a growth plate in the front of the knee. With SLJ, however, the growth plate involved is located at the inferior patellar pole. This condition is typically seen in pre-adolescence or early adolescence before the growth spurt occurs. Risk factors are similar to those discussed for patellar tendonitis and OSD.

Symptoms of SLJ Syndrome
The classic finding in SLJ is tenderness and swelling at the bottom of the patella. Pain is usually noted during or after activities, such as running, jumping, squatting or climbing stairs.

Expected Outcome
Treatment is similar to that discussed with OSD, above.

Patellofemoral Syndrome (PFS)

Patellofemoral syndrome describes an irritation of the patella as it moves within the groove of the femur. For a variety of reasons, the patella can move slightly off-track during movement of the knee, causing pain. In addition to overuse, risk factors include weakness in the lower leg and core muscles, how the patellar sits in the groove (too far to the side, too high, too low), poorly aligned knees (knock knees) and flat feet.

Symptoms of PFS
Pain is usually described as achy, but may also be sharp. Pain is most often reported on the inside or outside of the patella or sometimes all across the front of the knee. It is typically worse with running, jumping, squatting or sitting for long periods of time, arising from a sitting position and stair climbing.

Expected Outcome
Symptoms often wax and wane over a period of years and are usually worse during periods of heavy activity. Improvement is typically noted with activity modification, ice, anti-inflammatory medicine and rehabilitation exercises. Some cases may require a knee brace called a patellar stabilizer brace that helps keep the patella seated in the groove of the femur. Surgery is rarely needed for cases that do not respond to conservative therapy.

General Treatment Recommendations for Knee Injuries

Knee Injury Prevention

Proper conditioning, including a complete warm up that incorporates dynamic (moving) stretching, can help decrease the risk of knee injuries. In addition, having equal strength and flexibility in the front and back of the leg is important. The best time to work on flexibility is after a workout. Static (still) stretches should be held for at least 30 seconds. Always increase workout demands, including sets, reps, weight, time and distance, gradually to allow the body to adjust to new stresses placed on it. Finally, proper technique and form in running, jumping, landing, cutting and tackling should be taught at practices. The right equipment, such as appropriate length of cleats for the playing surface, should be used.

Treatment Considerations

Ice and anti-inflammatory medication can help reduce both swelling and pain. Cold packs should be applied for 10-15 minutes every 2-3 hours. Crutches may be recommended if an athlete is unable to walk without a limp. Sometimes braces may be used to stabilize the knee. Home exercises to work on range-of-motion, stretching and strengthening may be prescribed after evaluation by an athletic trainer, physician or other medical professional, or the athlete may be referred for formal rehabilitation.

Medication

Any medication should be taken under the direction of a physician. Most suggest non-steroidal, anti-inflammatory medications, such as ibuprofen, or other minor pain relievers, such as acetaminophen. Ibuprofen should not be taken for seven days before surgery. If any bleeding, stomach upset or signs of allergic reaction occur, contact a physician.

Resources

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4. McCambridge TM, Stricker PR. Strength Training by Children and Adolescents. *Pediatrics*. 2008;121:835-840.

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7. Yu B, McClure SB, Onate JA, Guskiewicz KM, Kirkendall DT, Garrett WE (2005) Age and gender effects on lower extremity kinematics of youth soccer players in a stop-jump task. *Am J Sports Med* 33:1356–1364

Nationwide Children's Hospital Sports Medicine provides care at nine locations throughout central Ohio. For maps, directions and office hours of our locations, visit **NationwideChildrens.org/Sports-Medicine-Locations.**

To schedule an appointment at any location, call (614) 355-6000.

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