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Overview of Injuries in the Young Athlete

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Abstract

It is estimated that 30 million children in the US participate in organised sports programmes. As more and more children participate in sports and recreational activities, there has been an increase in acute and overuse injuries. Emergency department visits are highest among the school-age to young adult population. Over one-third of school-age children will sustain an injury severe enough to be treated by a doctor or nurse. The yearly costs have been estimated to be as high as $US1.8 billion.

There are physical and physiological differences between children and adults that may cause children to be more vulnerable to injury. Factors that contribute to this difference in vulnerability include: children have a larger surface area to mass ratio, children have larger heads proportionately, children may be too small for protective equipment, growing cartilage may be more vulnerable to stresses and children may not have the complex motor skills needed for certain sports until after puberty.

The most commonly injured areas of the body include the ankle and knee followed by the hand, wrist, elbow, shin and calf, head, neck and clavicle. Contusions and strains are the most common injuries sustained by young athletes. In early adolescence, apophysitis or strains at the apophyses are common. The most common sites are at the knee (Osgood-Schlatter disease), at the heel (Sever's disease) and at the elbow (Little League Elbow). Non-traumatic knee pain is one of the most common complaints in the young athlete. Patellar Femoral Pain Syndrome (PFPS) has a constellation of causes that include overuse, poor tracking of the patellar, malalignment problems of the legs and foot problems, such as pes planus. In the child, hip pathology can present as knee pain so a careful hip exam is important in the child presenting with an insidious onset of knee pain. Other common injuries in young athletes discussed include anterior cruciate ligament injuries, ankle sprains and ankle fractures.

Prevention of sports and recreation-related injuries is the ideal. There are six potential ways to prevent injuries in general: (i) the pre-season physical examination; (ii) medical coverage at sporting events; (iii) proper coaching; (iv) adequate hydration; (v) proper officiating; and (vi) proper equipment and field/surface playing conditions.

1. Epidemiology of Youth Sports Injuries

The intention of this paper is to describe the epidemiology of youth sports injuries, to present an overview of the most common acute and chronic overuse injuries that present to emergency departments and doctor's offices, and to discuss prevention strategies.

Half of all children aged 5–18 years in the US are thought to participate in organised sports programmes.[1] This means that an estimated 30 million school-age children are involved in sports, which represents a substantial increase over the last 20–30 years.[2] In recent years, more and more athletes are undertaking intense training at younger ages or participating in multiple sports in one season, thereby exposing themselves to more opportunities for acute injury and increasing their risk for overuse injuries. One study estimated that there is an average of 2.6 million emergency department visits for sports-related injuries per year for individuals aged 5–24 years.[3] Across all ages, the peak incidence of emergency department visits for sport-related injuries occurs at ages 5–14 years and tapers gradually with age. Visit rates for sports injury are highest for school-age children (5–12 years), adolescents (13–18 years) and young adults (18–24 years), compared with other age groups.[3] Fortunately, fatalities are rare, with most due to cardiac causes or attributable to heat-related injury.[4] It is estimated that 38% of high school children and 34% of middle school children will sustain a physical activity-related injury that will be treated by a doctor or nurse.[5] It is likely that the actual number of injuries is larger because many either do not seek medical attention or the injuries go unreported. The yearly cost of treating these injuries is estimated to be $US1.8 billion.[6]

It is difficult to obtain data on the relative risks (based on injury rates) of various types of sports for youth because exposure data across sports are limited. The most frequent sports-related activities causing emergency department visits include pedal cycling, basketball and football.[3,7] However, this does not mean that these activities are more dangerous than others as there may be more people engaging in these activities. Surveillance of high school organised sports has found that football had the highest injury rate with 41–61% of athletes injured annually.[8,9] Other sports with high annual injury rates include wrestling and gymnastics (40–46%), basketball (31–37%), volleyball, baseball, soccer, cross country, softball and track (7–18%).[6] These data, of course, reflect only the frequency of injury and not the severity of such injuries.

There are physical and physiological differences between the young athlete and the mature adult athlete that may cause children to be more vulnerable to injury. Children have a larger surface area to mass ratio. They also have larger heads compared with the rest of their bodies, which can lead to a higher proportion of head injuries than in adult athletes. Since children are smaller and vary in size, protective equipment may not be appropriately sized. Children have open physes (growth plates) and there is the theoretical possibility of damage with certain activities (such as weightlifting) which can lead to early closure. Furthermore, growing cartilage is more susceptible to stress, which may be a factor in some overuse injuries. Depending on childrens' developmental levels, their lack of mature motor skills may place them at risk for injury. Children do not master complex motor skills until late childhood (age 10–12 years) and during puberty there is a temporary decline in coordination and balance.[10]

Pre-pubescent children are theoretically less likely to sustain injuries due to acute blunt trauma. This is because they generate lower speeds and

have less mass and strength. While children generate less force, their bones are softer and more porous and the tendons have greater strength. This leads to a greater likelihood of fracture, especially at the growth plates. The adolescent athlete, however, is more vulnerable to injury than the pre-pubescent child because circulating androgens cause the development of greater mass and speed and therefore power. Peak muscle strength occurs at peak height velocity for girls and 6–12 months later in boys. This, combined with impulsiveness and recklessness typically seen in teenagers, may increase the likelihood of injury.

Pre-pubescent athletes may also be more likely to sustain heat injuries, primarily because children have a higher threshold for sweating and a lower sweat rate. The knowledge that pre-pubescent children do not acclimate to heat as well as adolescents and adults is important in preventing heat illness.

2. Selected Injuries in Young Athletes

The most commonly injured parts of the body are the ankle and knee, followed by the hand, wrist, elbow, shin and calf, head, neck and clavicle, shoulder, foot, back, hip and hamstring.[11] Younger children tend to sustain injuries to their upper extremities and head, while older children and adolescents tend to sustain more injuries to their lower extremities. Contusions and strains are probably the most common injuries sustained in young athletes. Contusions are bleeds into the muscle and soft tissues (bruise). A strain is an injury caused by stretching or exerting a muscle beyond its limits. A sprain is any injury to a ligament that is either a mild stretch to a complete disruption of the ligament. Children and adolescents with these types of injuries may not seek medical attention unless the injuries are serious enough to prevent play or cause significant pain. Contusions are most common in contact sports such as football and hockey where collision with other players is expected. Muscle strains can occur in any athlete, but especially in runners and in children participating in sports where running is part of the game, such as soccer and basketball. Muscle strains are more common in older adolescents and adults, whereas strains at the apophysis or apophysitis are more common in early adolescence. Recommended treatment includes rest, ice and elevation of the affected body part. Athletes can return to play when pain has subsided, and strength and range of motion in the affected extremity is restored.

The apophysis is the point of attachment of a tendon to bone. This is a type of ossification centre. Apophysitis is caused by micro-avulsions at the bone-cartilage junction.[12] It is caused by repetitive motion and overuse occurring during periods of rapid growth. The most common sites for apophysitis are the insertion of the patella tendon on the tibial tubercle (Osgood-Schlatter disease), the insertion of the Achilles tendon and plantar fascia on the calcaneus (Sever's disease or osteochondrosis of the calcaneus) and at the flexor/pronator origin on the medial epicondyle of the elbow (Little League Elbow). Sever's disease typically occurs between ages 7–10 years, Little League Elbow under age 10 years, and Osgood-Schlatter disease between ages 11–15 years.

Sever's disease is seen in children who are contracted in the gastrocnemius-soleus muscle complex and who are very physically active. On examination, these children have tenderness over the posterior aspect of their heel and dorsiflexion at the ankle is limited. Treatment involves rest and heel lifts to relieve the tension on the heel. More importantly, these children need to stretch their heel cords daily. Rest will decrease the pain.

In children with Osgood-Schlatter disease, there is tenderness over the tibial tubercle. There can also be swelling and prominence of the tibial tubercle. Treatment includes rest, ice, analgesics/anti-inflammatory medications and quadriceps stretching exercises. Knee straps (e.g. Cho-Pat™[1] straps) are often helpful for some athletes because they decrease the traction forces on the tibial tubercle.

Little League elbow is seen in skeletally immature pitchers who throw for long periods of time.

1 Use of tradenames is for product identification purposes and does not imply endorsement.

On examination, there is tenderness over the medial and lateral epicondyles. The injury occurs during the acceleration phase of pitching where force is exerted on the medial side of the elbow and compression on the lateral side. To prevent this injury, leagues and recreation programmes impose limitations on the number of innings pitched per game (3–4 per game) and/or number of pitches per week (less than 200). Treatment should include rest until there is no more pain, stretching and muscle strengthening, and gradual resumption of throwing when strength and range of motion have returned.[13]

Nontraumatic anterior knee pain is one of the most common complaints in the young athlete. Patellar femoral pain syndrome (PFPS) is the term used when an athlete has a chronic, dull, aching knee of unknown aetiology. Typically, the patient points to the patella as the source of pain, but the pain can seem to originate under or around the patella. The patient may state that his or her knee hurts when sitting for prolonged periods of time and when climbing stairs. The onset is insidious. On examination, the patient may have tenderness to palpation at the medial facet, pain with or without patellar grind (compression of the patella) and pain with isometric quadriceps contraction with the knee in full extension.[14] All young athletes presenting with insidious onset of knee pain should have a hip examination as well. Slipped capital femoral epiphysis (SCFE) of the hip is seen in the pre-adolescent and early adolescent age groups, especially in overweight boys, and is more common in the African-American population. SCFE is a type of fracture that necessitates urgent surgical intervention. There should be strong consideration of radiographic examination in children who fit this profile and complain of knee pain.

Multiple theories have been proposed as to the aetiology of PFPS. The prevailing view is that the cause is multifactorial, including biomechanical problems, muscle dysfunction and overuse. The patella articulates with the patellofemoral groove in the femur. There are multiple forces that help the patella track properly. The quadriceps muscles and various soft tissues are involved with the patellofemoral complex. Poor tracking of the patella can be caused by a problem with the patellar stabilising mechanisms as well as certain biomechanical problems in the patient. This includes malalignment of the lower extremities, muscle weakness/inflexibility and foot problems, such as pes planus (flat feet) and pes cavus (high arched feet). Assessing the young athlete for these issues will help direct treatment. These treatments include relative (active) rest, shoe inserts (orthotics) for pes planus, ice, analgesics and anti-inflammatory medications, knee sleeves, braces or taping, and strengthening and stretching exercises. The quadriceps are the most important muscle group to strengthen because of their prominent role in patellar tracking.

Acute ankle injuries are common in young athletes. The most common ankle sprains occur when the foot is plantar flexed and inverted. This leads to a lateral ankle sprain. In the athlete with open physes, Salter-Harris type I and II fractures should also be considered because the mechanism of injury is the same. Any child with swelling and tenderness over the lateral malleolus should have ankle x-rays to determine if there is a fracture. Salter-Harris I fractures of the ankle are difficult to detect on x-ray and therefore children with open growth plates with swelling and tenderness of the lateral malleolus should be immobilised in a cast for at least 3 weeks. Syndesmosis sprain or 'high ankle sprain' should also be considered in the athlete with ankle injury. On examination, there is pain at the ankle with a squeeze test of the tibia and fibula. X-rays of the ankle should include anteriorposterior, lateral and mortise views as well as a view of the proximal fibula. The same mechanism of injury causing a syndesmotic injury may also cause a proximal fibula fracture (Maisonneuve's fracture). Early treatment of ankle sprains includes rest, ice, compression and protection. After the first few days, the athlete should begin range of motion and flexibility exercises and strengthening as tolerated. The athlete can gradually return

to play if range of motion, strength and sports-specific skills are restored.

In recent years, the number of young athletes presenting with anterior cruciate ligament (ACL) injuries has risen dramatically. Children are increasingly participating in sports where the mechanism of ACL injury is more common, especially girls who are more vulnerable to ACL injury. It is not entirely clear why girls are more vulnerable but some common contributing causes often cited include: a smaller ligament with a smaller intercondylar notch of the femur, less strength and conditioning, differing playing mechanics during play and anatomic alignment. These injuries most often occur in non-contact circumstances. ACL injury occurs during activity that involves deceleration or change of direction forces, as occurs while playing basketball, football and soccer, but is not limited to these sports.[15] The patient may describe feeling a 'pop' at the time of injury and swelling of the knee is common within 6 hours. The athlete is usually unable to continue. The physical examination usually determines the diagnosis. The Lachman test is considered the most sensitive test for ACL injury.[16] This test is performed with the patient supine and the affected knee at a 20–30°angle. The tibia is then translated anteriorly while keeping the thigh from moving. The absence or presence of an endpoint is noted. If no endpoint is felt by the examiner, then an ACL injury is likely. Increased translation is suspicious for ACL injury. Other physical examination tests to assess ACL integrity include the anterior drawer and pivot shift tests, but these are considered less sensitive than the Lachman test.

Radiographic studies are strongly recommended in children and adolescents with suspected ACL injuries. These are done to rule out associated intra-articular fractures. Magnetic resonance imaging studies are used to confirm the diagnosis of ACL injury and to rule out other associated injuries, such as meniscal tears. As many as 50–70% of patients with ACL injury will have meniscal injuries.[15] Avulsion fractures of the tibial spine can occur in the skeletally immature athlete. This is caused by an injury at the site of the insertion of the ACL on the tibia. This injury necessitates an urgent referral to an orthopaedic surgeon for probable surgical management. All ACL injuries, even those not involving the tibial spine, should be referred to an orthopaedic surgeon experienced in the care of ACL injuries.

3. Injury Prevention

We have discussed selected common musculoskeletal injuries in children and adolescents and have demonstrated physiologic and developmental risks for injury in this age group. Injuries are often considered an inevitable part of sports. However, like other injuries, sports injuries are potentially avoidable. For youth, this is especially salient since the effects of childhood sports injuries can linger into adult years. General injury prevention strategies are sometimes conceptualised as the three E's: (i) education or behavioural interventions; (ii) environmental interventions; and (iii) enforcement or legislative interventions. The same strategies should be considered for sports-related injuries and a multi-level approach may be needed. For youth sports injuries specifically, Hergenroeder[4] outlined six potential mechanisms for reducing injuries, including: (i) the pre-season physical examination; (ii) medical coverage at sporting events; (iii) proper coaching; (iv) adequate hydration; (v) proper officiating; and (vi) proper equipment and field/surface playing conditions. Included in the latter category would be the development and regulation or legislation of protective gear use and redesign or elimination of equipment.

The pre-participation physical examination presents an opportunity to prevent injury. Primary objectives for this visit[17] include: (i) detection of conditions that may pre-dispose to injury; (ii) detection of conditions that may be life threatening or disabling; (iii) identification of musculoskeletal problems that need rehabilitation prior to participation; and (iv) meeting of legal and insurance requirements. Other important objectives include: (i) review of general health including psychological

health; (ii) counselling on health-related issues; and (iii) assessment of fitness level for specific sports.

In addition to detecting medical conditions, the pre-participation visit provides the opportunity to address medical and psychosocial issues that are important to general health, although not directly relevant to athletic participation. For a large percentage of adolescents, the pre-participation athletic visit may be their only contact with a health provider and their only access to healthcare.[18-21] In addition, it is a 'teachable moment' to address injury prevention strategies and related issues, such as performance-enhancing drug use and psychological stress. Excessive pressure to perform well in sports, poor psychological coping skills and lack of social support have been associated with injury.[22]

Discussion of pre-season conditioning is important during the pre-season evaluation. Reminding football players to frequently hydrate during practices and games is important. Recommendations for leg strengthening, under the guidance of athletic trainers, for girls who play soccer and basketball can prevent knee injuries. Reminders to throwing athletes of the number of pitches per week should be included in the pre-participation evaluation visit. Proper warm-up and stretching for all athletes should be emphasised. The office visit for a minor sports injury provides an opportunity for secondary prevention of further injury. A young athlete with multiple ankle sprains, for example, could be sent to physical therapy for rehabilitation and prescribed an ankle brace for stability for return to play. Exploring with the athlete the type of surface he or she is practising and playing on may also help prevent future injury.

Prevention of sports injuries requires advocacy to ensure a proper environment for sports participation. This includes appropriate adult supervision, proper coaching and officiating, and safe equipment and play locations (playgrounds, playing fields, surfaces, etc.). In one surveillance study of adolescent sports injuries in an urban area, 16% of sports injury emergency department visits and 20% of hospitalisations were related to equipment and environmental factors that may be amenable to prevention strategies.[12] Knowledge of physiologic risk for injury in the age group, as well as behavioural and environmental risks, can assist in the prevention, diagnosis and management of sports injuries in children and adolescents.

4. Conclusion

An ever increasing number of children are participating in organised sports and recreation programmes. Sports participation provides many benefits including increased fitness, increased motor coordination and improved socialisation skills. However, there is the risk of injury. Over a third of young athletes will sustain an injury that will bring them to medical attention. Physicians who treat these children should be aware of the physiological and developmental differences between the young athlete and the more mature athlete, both for diagnostic purposes and to give anticipatory guidance on injury prevention. Advocating for injury reduction practices, such as proper equipment and surfaces, proper coaching, medical coverage and adequate hydration, should be a goal of medical practitioners caring for young athletes.

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