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Physeal (growth plate) Injuries: What to Know and What to be Aware of in Young Athletes

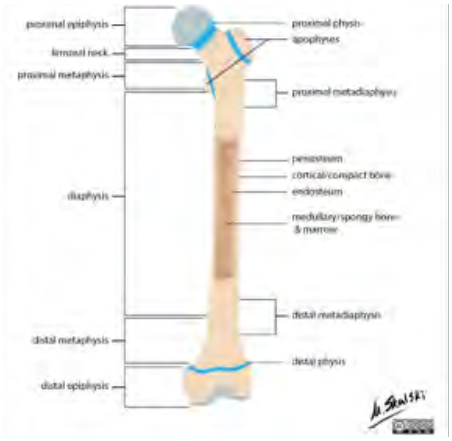
By Ryan Kelln, DO and Alex Diamond, DO, MPH

It is currently estimated that over 30 million youth between the ages of 6 and 18 participate in organized sports and millions more in recreational activities. Although youth sports remain an overall positive endeavor, changes in culture and training raise significant concerns on how this trend may affect the unique anatomy and physiology of young athletes compared to their adult counterparts. One of the biggest differences between young and adult athletes is the presence of growth plates, otherwise known as physes. Both acute and repetitive or chronic forces can affect the physes, however, with improved understanding of physeal injuries and their appropriate treatment we can reduce the impact they have on our youth participating in sports.

Anatomy of the Developing Bone

In order for the body to gain height and its mature shape, the bones of a child need to have the ability to grow. Growth plates are made up of different layers of developing, rubbery and flexible tissue called cartilage that allows the bone to grow and ultimately mature into the mineralized bone that makes up the adult skeleton. When a child's bones have reached skeletal maturity, the growth plates ossify (harden) and fuse together forming one complete bone.

There are two types of physes. One is located at end of long bones (physis) and adds length as one gets older, while the other is at sites where some of the major muscle tendons attach to bone (apophysis) thereby contributing to adult shape but not growth.



Vulnerability to Injury

Physes are subject to constant change during the body's growth phase and therefore, are susceptible to different injury patterns than those seen in a fully developed adult bone. Studies have shown that there is a decrease in the strength of the physes during times of rapid growth, with the most risk occurring during puberty. The increase in rate of growth in addition to the structural make-up of the cartilage results in a more fragile zone in the bone. It is also hypothesized that the bone mineralization in the physis may lag behind the longitudinal growth during growth spurts making this area less solidified and therefore at increased risk for injury. Multiple studies support this hypothesis with an increase in incidence of physeal injuries noted during pubescence.

In addition, unlike the end of adult bones that have a dense ossification, the growth plate creates a weakened structure that is easily affected by increased stress. With the physis considered the weak link, mechanisms that may result in muscle or ligamentous injury in an adult, are more likely to result in damage to the growth plate and bone of a child.

Because changes in physes occur over a large span of years, this area is subject to a variety of injuries that are classified as either acute (immediate onset) or chronic (repetitive insult). An injured growth plate might not do its job properly, which can lead to crooked or misshapen bones, limbs that are too short, or even arthritis.

Acute Physeal (Growth Plate) Injuries

Most acute injuries to the growth plates are the result of a fall. There is usually a greater force involved due to increased speed, like running or falling from an elevated position. Sports make up the largest proportion of acute injuries (33%) with hockey, football and baseball being the biggest culprits, while recreational activities such as biking, skiing and snowboarding come in second (22%).

Approximately 15% of all fractures in children involve the physis. The most widely used classification system for acute physeal injuries was developed by Salter and Harris and depicted five different types of growth plate fractures. Type I traverses through the growth plate, separating the epiphysis from the metaphysis. Type II, which is the most common type, is a fracture through the growth plate, but ultimately breaks out through a portion of the metaphysis. Type III fractures also traverse through the growth plate, and ultimately breaks out through the epiphysis. Type IV is a fracture that extends from the joint surface, through the growth plate

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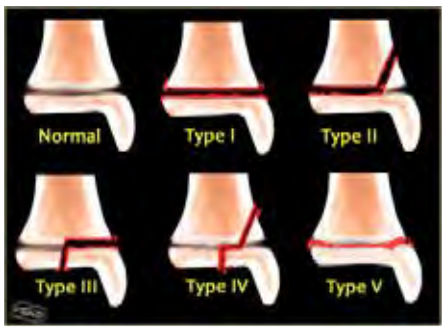

and into the metaphysis. Type V is a compression fracture or crush injury of the growth plate.

Treatment for acute physeal injuries may involve immobilization (cast or splint), manipulation or even surgery depending on the type of fracture and its location. Prognosis for Type I and Type II fractures is fairly good since the fracture does not usually damage the growth plate itself, it just separates it from the metaphysis and blood circulation to the physis is usually unaffected. Type III fractures usually have good prognosis as well if the blood supply to the affected portion of the epiphysis is still intact and the fracture is not displaced. Type IV injuries usually require surgery to align the growth plate and joint surface. Type V injuries have a poor prognosis unless the growth plate is able to be completely realigned.

Chronic Physeal Injuries

It is believed that repetitive stress to the growth plate via overuse and inadequate recovery time can effect this portion of bone due to altered blood flow. Although these changes usually resolve with rest or modified activity, there have been cases where this repetitive stress has resulted in breakdown of the bone. Consequences can range from angular deformities to slowing down the rate of growth to even complete cessation of growth.

Chronic injuries can be seen in any sport that puts repetitive stress onto a single joint, but the most recognized of these injuries occurs in baseball. "Little League Shoulder" is a term used to describe chronic stress to the physis of the proximal humerus of pitchers. These athletes usually complain of persistent anterior shoulder pain in their throwing arm. It is believed that the repetitive twisting motion this part of the body goes through to while pitching sends a repeated stress through the weakest link in the shoulder joint system, which is the developing physis. Although given the term "Little League Shoulder" due to its common presentation in baseball pitchers, it can occur in any athlete that uses a repetitive overhead motion. Locations of other common chronic physeal injuries include the distal humerus and proximal radius of baseball players, the middle phalanx in climbers and the distal radius in gymnasts. The diagnosis of chronic physeal injuries is usually made by history and physical exam, however more advanced cases can be confirmed with widening of the growth plate visible on X-ray.

With proper diagnosis, the prognosis for these injuries are good. Most athletes see their symptoms resolve by relieving the chronic stress placed on the physis through activity modification, improved mechanics and correcting biomechanical imbalances with physical therapy.

Apophyseal Injuries

Although insult to longitudinal growth of the bone does not occur, injuries to these sites can result in significant pain and activity limitation. There are both acute and chronic versions of these injuries as well.

Overuse and subsequent repetitive traction of the inserting muscle-tendon complex puts stress on to the apophysis resulting in pain and a condition known as apophysitis. The apophysis is the weakest link and takes the brunt of the forces from the muscle-tendon that attaches to it. The most common sites for this injury include the tibial tubercle (the attachment of the patellar tendon) which is called Osgood-Schlatter disease, the calcaneal apophysis (the attachement of the Achilles tendon) which is called Sever's disease, and the medial epicondylar apophysis (the attachment for the forearm flexing and pronating muscles) which is called Little League Elbow.

On the other hand, apophyseal avulsion fractures are usually acute, and the displaced fragment may be bony or cartilaginous. The mechanism of injury is from a violent muscle contraction that occurs across an open apophysis (kick, sprint, etc). Typical symptoms include sudden onset of pain, swelling, and weakness. X-rays will confirm the diagnosis.

Treatment of all of the apophyseal conditions is usually non-operative including rest, reduction of the repetitive stress and physical therapy to address underlying biomechanical issues.

Conclusion

With rising numbers of youth sport participants, more athletes playing year round sports and athletes specializing in one sport at a younger age, it is important to assess the risks this has on the developing body and try to protect these young athletes from the possible harms this may cause. Both acute and chronic physeal injuries can have a long-term impact on the growth and performance of young athletes. Proper recognition and response starts with understanding the common causes of these injuries and the basic anatomy that makes these athletes unique.

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5 Things to Know About Sickle Cell Trait

By Jennifer Gaitley, MD

As spring sports begin and temperatures increase, it is important to address factors that may impact training and injuries in athletes of all ages. Knowing your health history is a vital part of staying safe while exercising and something that you, your primary care and sports medicine doctors should take seriously. While many people have probably heard of sickle cell disease, they may not be familiar with sickle cell trait, a significant condition to consider when exercising.

Here are 5 things to know about sickle cell trait.

1. What is sickle cell trait? Sickle cell trait is not a disease. It is a condition where a person is born with one normal gene for hemoglobin and one gene for abnormal or sickled hemoglobin. Sickle cell trait is a lifelong condition that does not change over time.

2. Who gets sickle cell trait? Sickle cell trait is more common in people who have ancestors from Africa, South or Central America, the Caribbean,

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Mediterranean countries, India or Saudi Arabia. It occurs in about eight percent of the African American population within the United States.

3. Why is it important? People with sickle cell trait should not be excluded from sports participation but should be aware of possible complications during intense physical activity. During exercise, red blood cells that have the sickle hemoglobin can change shape and clump together in the bloodstream, blocking normal blood flow to muscles. Although rare, some athletes have had significant physical distress, collapsed and even died during intense exercise. Heat, dehydration, altitude and asthma can increase the risk for complications associated with sickle cell trait, even with mild or moderate intensity exercise.

4. How do I know if I have sickle cell trait? Most U.S. States test for sickle cell trait at birth but many athletes with the trait do not know that they have it. You can ask your primary care doctor to check your records or request a blood test to see if you have sickle cell trait. The NCAA recommends that all student-athletes have a confirmed sickle cell trait status.

5. What can I do to prevent illness or injury? Know your sickle cell trait status! Start with a slow and gradual conditioning regimen before doing any intense exercise. Once you have started more intense drills, take rest and recovery breaks between repetitions. Stop exercise immediately and tell your athletic trainer or coach if you have muscle pain or feel unusually weak, tired or out of breath. Do not do vigorous exercise while you are feeling ill, especially if you have a fever. Stay well hydrated, especially when it is hot or humid.

Choosing Wisely®: Stress Cardiac Imaging

By Anne Marie Zeller, DO, MSc

Choosing Wisely® is an initiative of the American Board of Internal Medicine and is supported by multiple medical societies, including the American Medical Society for Sports Medicine. Each society was asked to contribute five diagnostic tests or treatments that both physicians and patients should question. The highlight this issue is:

Don't perform stress cardiac imaging or coronary angiography in patients without cardiac symptoms unless high-risk markers are present.

Returning or starting a new exercise regime as an adult can be a daunting task, especially if you are currently being treated for high blood pressure, diabetes, high cholesterol, smoking cessation or other diseases.

This issue will highlight some of the steps to returning or starting a new exercise and help clarify who is at high risk for cardiovascular events and who may need further cardiac evaluation in the form of cardiac stress test and/or cardiac angiography.

Before starting a new exercise regime, it is recommended that you receive a physical examination from your primary or sports physician, which may include cholesterol and fasting glucose. Your physician may ask you if you have had cardiac or respiratory symptoms while at rest or during activity. If you answer "yes" to these questions, your doctor may further discuss about cardiac stress testing or coronary angiography as coronary artery disease (CAD) can cause these symptoms and can lead to chest pain and even myocardial infarction (MI or heart attack).

Current traditional risks of developing CAD include high LDL ("bad" cholesterol), low HDL ("good" cholesterol), high blood pressure (hypertension), diabetes, smoking, lack of physical activity, family history of early (<50 years old) CAD events, post-menopausal women and men greater than 45 years old.

It is currently recommended for patients without symptoms but who have high risk markers, including patients older than 40 years old with diabetes, peripheral artery disease, and/or > 2% yearly risk of cardiac event rate undergo cardiac stress testing and/or coronary angiography prior to starting an exercise regime. Your yearly cardiac event rate is calculated using the Framingham Calculator that uses your sex, age, smoking status, systolic blood pressure, total cholesterol and HDL ("good" cholesterol) and gives your risk of a cardiac event in the next 10 years.

If you do not have any cardiac or respiratory symptoms and no high risk markers, it is recommended by the Choosing Wisely® campaign that you do not need to undergo a cardiac stress test or coronary angiography.

Once you are clear to start activity by your physician, he/she may then discuss yourF.I.T.T (Frequency. Intensity. Time. Type) Prescription. Frequency is how often are you going to do cardiovascular and strength exercises. Intensity means how hard you are going to work during your sessions. Your doctor can discuss the intensity and your target heart rate and strength training weights, repetitions and sets. Timing is how long you are going to do cardiovascular and strength exercises. Current recommendation is 150 mins/week or 30-60 mins 3-5 times week of cardiovascular exercise. Type means what exercise is safe and fun for you.

It is important to note that if you do have risk factors of CAD, those do not exclude you from starting or continuing exercise, but you will need to work with your physician to develop a safe exercise program. Exercise, healthy lifestyle and diet are all very important in preventing the start and/or progression of many diseases; examples include diabetes, high cholesterol, depression and high blood pressure.

Editor-in-Chief: Jeffrey Bytomski, DO AMSSM is a multi-disciplinary organization of 3,000+ sports medicine physicians dedicated to education, research, advocacy and the care of athletes of all ages. The majority of AMSSM members are primary care physicians with fellowship training and added qualification in sports medicine who then combine their practice of sports medicine with their primary specialty. AMSSM includes members who specialize solely in non-surgical sports medicine and serve as team physicians at the youth level, NCAA, NFL, MLB, NBA, WNBA, MLS and NHL, as well as with Olympic teams. By nature of their training and experience, sports medicine physicians are ideally suited to provide comprehensive medical care for athletes, sports teams or active individuals who are simply looking to maintain a healthy lifestyle. Find a sports medicine physician in your area at www.amssm.org.

A Beginner's Guide to a Proper Bike Fit

Caitlyn Mooney, MD

Bicycling is a popular form of physical activity for people of all ages and offers many health benefits. As the weather gets warmer many people will decide to start cycling for recreation, health benefits, or to train for a bike ride, race or triathlon. Riding a bicycle is an excellent way to improve cardiovascular fitness and strength and is also easy on joints. There are many types of cycling including commuting, road biking, mountain biking, BMX riding and more.

In order to safely enjoy the benefits of bike riding some basic equipment is necessary. The most important are a bicycle and a helmet. Bicycles vary greatly in terms of cost, performance, and materials, however, the most important thing to consider when purchasing a bicycle is proper bike fit. An improperly fitted bicycle can result in poor performance, overuse injuries, discomfort, sores or even injuries from crashing. When cycling at 90 rpm, cyclist's legs make 5,400 revolutions an hour. Especially on a road bicycle where the strokes are nearly identical, a minor misfit can lead to pain or an overuse injury. Common complaints that can be attributed to poor bike fit include knee pain, lower leg pain, wrist pain, back pain, neck pain, perineal pain, hand pain and numbness.

Factors that come into play when deciding on a bike include the type of riding, budget, environment/ terrain, volume of riding and level of competition. An appropriately fitted bicycle is critical for all types of cycling. When purchasing a bicycle, it is important to buy an appropriate frame size and make the bicycle fit the rider and not the rider fit the purchased bicycle.

A bicycle fit appraises the rider's interaction with the bicycle. There are several goals of a bicycle fit including comfort, maximizing efficiency, prevention of discomfort or injury and accommodating physical or medical impairments. These goals will vary among individual riders. More competitive riders may place emphasis on performance or efficiency while recreational riders may be more concerned with comfort.

There are many different types of bicycle fits. The most basic type of bike fit involves measuring the cyclist and the bicycle at rest. More advanced fits may include measurements of power while riding, pressure mapping or even video analysis. Basic fitting can be done by any professional who has knowledge of bicycles or bicycle medicine however many of the more advanced techniques take more training or certification. Basic bike fits can be done in bicycle shops as well as physical therapy or physician offices that offer these services. Advanced services may be more difficult to find, so it is important to ensure that the cyclist's goals match what the professional offers.

While bicycle fit can be quite complex and beyond the scope of this article, there are basics that a rider should know. There are five contact points between the cyclist and the bike. The goal of the bike fit is to get these contact points in an acceptable position. The five contact points are between the hands/ handlebars; shoe, cleats, pedals; and pelvis/ saddle.

Below are some of the key components of a bike fit.

Frame Size: Frame size is mainly dictated by a person's inseam/height. The rider needs to have enough room to stand over the top tube so that no injury occurs during a rapid dismount. There are many measurement formulas and methods to optimally determine frame size.

Saddle Choice: Many components go into saddle choice including shape, materials and amount of padding. Most importantly, the saddle needs to be wide enough to support the rider's pelvis.

Saddle Height: Saddle height is determined by rider's inseam. The rider should have between 25-30 degrees of flexion at the knee when it reaches the 6 o'clock position (bottom of the pedal stroke) to maximize power output. Inappropriate saddle height is a common cause of iliotibial band or knee pain.

Saddle Tilt: For most riders a level tilt is best.

Saddle Fore/Aft: The saddle should be moved forward or backward so the center of the knee is over the center of the pedal at the three o'clock position.

Handle Bar Width: Handle bar width is determined by shoulder width.

Handlebar Reach/ Drop: This is the most individualized part of the bike fit. Many components go into the reach/ drop measurement including the top tube length, stem length, stem angle, and handle bar height. In general for road cycling the back should make a 45 degree angle with the top tube while the hands are on the brake hoods. There should be a slight bend in the elbows. A recreational rider may be comfortable in a more upright position.

Position of Cleat on Shoe: Generally the ball of the foot should lie directly over the axle of the pedal. Cleats can move in multiple directions to personalize the fit. Specialized orthotics and shoe wear can be used to help with anatomical variances of the lower extremity.

Cycling provides numerous health benefits, however; the repetitive motion puts stress on multiple body parts and is associated with overuse injuries. The basic goals of all bike fits is to decrease the risk and have a comfortable safe and efficient ride.

Resource courtesy of SportsMedToday.com.