Abstract:
The number of children and adolescents participating in sports is on the rise. There has been an increase in the incidence of overuse injuries and a concern that overscheduling, multi-day tournaments, and playing on multiple teams in a single season contribute to the development of these injuries. Skeletally immature children and adolescents are susceptible to overuse injuries to the physes and apophyses, which can be difficult to diagnose, especially because many do not have positive radiographic findings. This article describes the pathophysiology, diagnostic criteria, treatment, and prevention of lower extremity overuse injuries in the skeletally mature and immature athlete.

Keywords:
overuse injuries; pediatric athlete; apophysitis; stress fracture; tendinopathy; osteochondroses; bursitis; shin pain

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Nontraumatic Sports Injuries to the Lower Extremity

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The number of children and adolescents participating in organized sports has grown considerably over the past 2 decades and is now estimated between 35 and 44 million annually.[1-3] The incidence of overuse injuries has paralleled the growth in youth sports participation.[4] Sports are the leading cause of injury among school-aged children,[5] with one study estimating that 2.5 million children younger than 19 years visit the emergency department (ED) each year for sports-related injuries.[6]

Overuse injury is defined as "repetitive application of submaximal stress to otherwise normal tissues, overwhelming the normal repair process."[7] Patients with overuse injuries usually describe an insidious onset of symptoms without a preceding traumatic event. These injuries include apophysitis, stress fractures, patellafemoral pain syndrome, osteochondroses, tendinopathy, and bursitis. Extrinsic factors (hard training surfaces, inappropriate equipment, poor technique, sudden increase in intensity, duration, or frequency of activity) and intrinsic factors (anatomic malalignment, previous injury, muscle weakness, or imbalance) contribute to the development of overuse injuries.[8,9] In addition there is growing concern that overscheduling with increased volume and frequency of exercise (participation in endurance events, weekend athletic tournaments, year-round training with single-sport specialization or on multiple teams and multisport athletes) contributes to the increase in overuse injuries.[4,10,11]

Treatment of overuse injuries can vary and is, in general, conservative. Initial management follows the PRICE guideline: protect by reducing tissue loading (cast, brace or cam boot), rest, ice, compression, and elevation.[11] Physical therapy and

rehabilitation modalities may then be of use to provide neuromuscular training to prevent future injury and stimulate healing.[12] This, in conjunction with injury prevention protocols, proper resting periods, and improved conditioning, may remedy most of these injuries. Rarely is surgical intervention required but may be considered in recalcitrant cases.[13,14]

This article focuses on lower extremity overuse injuries in the pediatric and adolescent population, including a review of relevant anatomy, pathophysiology, diagnostic criteria, and treatment guidelines. The aim is to provide the reader with a roadmap for evaluating and ultimately treating these injuries.

OSTEOCHONDROSES

Osteochondroses are overuse injuries to the osteochondral ossification centers. Osteochondroses are thought to be a form of necrosis of the bone and cartilage centers, possibly caused by disruption of vascular supply from repetitive stress and microtrauma. These "bone-cartilage" disorders are a heterogeneous group of injuries to the epiphyses, physes, and apophyses (growth centers) of children.[15,16]

Kohler Disease

Osteochondrosis of the tarsal navicular is known as Kohler disease. It occurs in children 2 to 9 years of age, and in boys more commonly than in girls. It presents with midfoot pain that is exacerbated by weight bearing and is sometimes associated with swelling. Patients will often walk on the lateral aspect of the affected foot. The history may include a preceding trauma. The condition can be bilateral in up to 25% of cases.[17] On physical examination, there is tenderness along the medial border of the midfoot as well as reproducible pain with resisted inversion. Radiographs may show sclerosis and narrowing or flattening of the tarsal navicular. In the ED, immediate management includes applying a splint or walking cam boot and referral to an orthopedic surgeon or sports medicine specialist in 1 week. Treatment is conservative including short-leg walking cast for 4 to 8 weeks, ice, and analgesics. Casting has been shown to decrease duration of symptoms.[18]

Freiberg Infraction

Freiberg infraction is an osteochondrosis of the metatarsal head, most commonly the second. The term *infraction* comes from the idea that this pattern is a combination of infarction and fracture. The mechanism of injury is thought to be caused by repetitive microtrauma and stress overloading leading to osteonecrosis, fracture, and, eventual, collapse of the metatarsal head. Adolescents (peak age of onset is typically 11-17 years) will report forefoot pain and, on examination, have tenderness and swelling over the second or third metatarsal head.[19] Radiographs may reveal collapse and sclerosis of the metatarsal head, which may result in shortening of the affected ray.[19,20] Treatment is conservative with avoidance of painful activity and sometimes with metatarsal padding. Cast immobilization may be necessary, especially in noncompliant patients.[20] Rarely, if extensive conservative management fails, operative intervention may be helpful. Operative management may include drilling of the metatarsal head, subchondral bone grafting, tendon interposition, dorsiflexion or metatarsal shortening osteotomies, or debridement and removal of loose bodies.[19,21,22]

APOPHYSITIS

An apophysis is an ossification center that serves as the attachment between the tendon and bone in a skeletally immature individual (Figure 1).

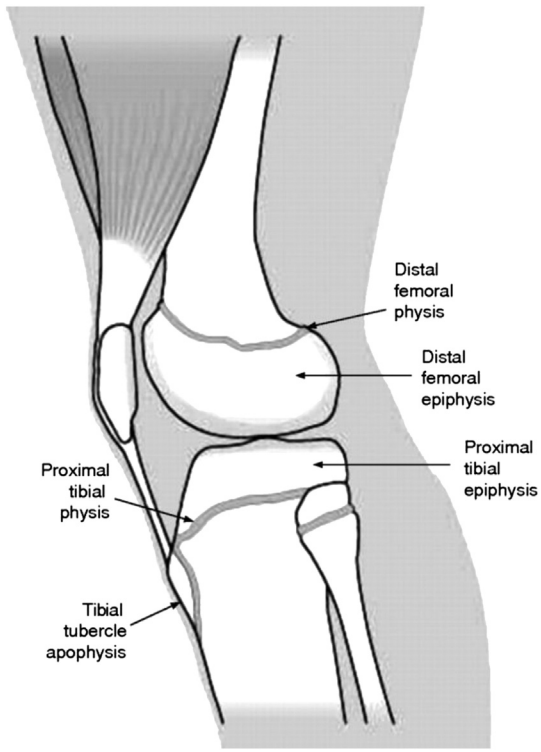

Figure 1. Sagittal view of the knee showing the epiphyses, physes, and tibial tubercle apophysis. Reprinted with permission.[126]