The case:

An 11-year-old gymnast presented with long-standing wrist pain. Radiographs were obtained.

Figure: Posteroanterior (A) and lateral (B) radiographs of the wrist.

Your diagnosis?

For answer see page 1072
Gymnast Wrist

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A 11-year-old gymnast presented with long-standing wrist pain and imaging consistent with gymnast wrist. Participation in gymnastics at a young age has become an increasingly popular pursuit, and the intensity of training and high level of bodily strain during these key years of growth raises concerns about the possibility of serious lasting injury. Gymnast wrist generally refers to nonspecific pain in the wrist of a gymnast; is caused by chronic compressive impact forces, torsional forces, and distraction; and most often refers to injury of the distal radial physis. Other overuse and acute wrist injuries in the gymnast include scaphoid impaction syndrome, scaphoid fractures and stress reactions, avascular necrosis of the capitates, lunate osteochondral defects, ulnar impaction syndrome, lunotriquetral impingement, dorsal impingement, carpal instability, tears of the triangular fibrocartilage, scapholunate or lunatotriquetral ligaments, cartilage injury along the distal radius and carpus, and dorsal carpal ganglia.

Etiology

Adolescents are especially vulnerable to injury because un-fused physes are more susceptible to damage, and adolescent bones become more porous and have a greater chance of fracturing with less severe trauma compared with those of younger children. During gymnastics training, the upper extremities are regularly used to support body weight. In this setting, the wrist becomes a common site of symptoms and injury. The joint is particularly at risk because it is excessively and repeatedly loaded in gymnastics, causing the tolerance limits of the physis to be exceeded. Furthermore, the wrist ligaments and joint capsule are 2 to 5 times stronger than the open physis, making the physis more susceptible to trauma in adolescent gymnasts.

The physis of the distal radius undergoes marked compressive loading and is subject to shearing forces during gymnastics routines, especially when the wrist is dorsiflexed. Floor exercise and balance beam maneuvers will direct the body’s forces onto the un-fused distal radial metaphyses in skeletally immature patients, resulting in widening of...
the physis, cystic change, and fragmentation of the adjacent metaphysis. These injuries occur as a result of chronic stress in the pediatric population and are diagnosed as Salter-Harris type I stress fractures.\textsuperscript{2,9} These fractures usually involve the hypertrophic zone of the physis, with resultant growth plate widening.

**Clinical Findings**

The classic clinical finding of gymnast wrist is wrist pain, sometimes accompanied by soft tissue swelling.\textsuperscript{9} Patients who have substantial injury to the distal radial physis may undergo premature closure of the physis that results in a shortened radius.\textsuperscript{10,11} In adolescence, the positive ulnar variance may result in injury to the triangular fibrocartilage complex, and these patients may progress to experience various symptoms of ulnar impaction syndrome in their late teenage years and adulthood.\textsuperscript{12} This syndrome includes fraying or tearing of the triangular fibrocartilage; damage to the articular cartilage of the lunate, distal radius, or triquetrum; tearing of the lunotriquetral ligament; and degenerative arthrosis of the involved bones in the late stages.\textsuperscript{3}

**Diagnostic Imaging**

**Radiography**

Radiography is the initial imaging study in a patient with significant wrist pain. Radiographic findings can vary according to the severity and longevity of the Salter-Harris type I distal radial fracture. Initial radiographs of patients with gymnast wrist may be normal or show subtle widening of the distal radial physis, more often along the volar aspect, and overlying soft tissue swelling (Figure 1).\textsuperscript{2,3} The uninvolved ulnar physis may be used as a gauge of normal physis width and contour. Continuous stress may result in further widening of the radial physis, irregularity, cystic change, and fragmentation of the adjacent metaphysis (Figure 2).\textsuperscript{5} These findings have been termed pseudorickets because of their similar imaging appearance to rickets and can resemble neuropathic changes.\textsuperscript{7} Premature closure of the distal radial physis and ulnar positive variance can be associated with gymnast wrist.\textsuperscript{10}

**Computed Tomography**

Although computed tomography with multiplanar reconstruction and 3-dimensional modeling is useful in evaluating the extent of complex fractures and degree of displacement, gymnast wrist is most often a solely cartilaginous or cartilaginous and soft tissue injury and computed tomography is not contributory.

**Magnetic Resonance Imaging**

Although the imaging findings of chronic physisal injury are often well demonstrated by radiographs alone, magnetic resonance imaging has been shown to detect radiographically occult osseous injuries and can change clinical management in a significant number of patients with physisal injury.\textsuperscript{5,7,10,13,14} Salter-Harris type I fractures of the distal radius are evidenced by widening and irregularity of the growth plate with increased T2 signal intensity, and bone marrow edema-like signal changes are often identified within the adjacent epiphysis and metaphysis (Figure 3). In cases where physisal damage may have caused early growth plate closure of the distal radial physis, magnetic resonance imaging can demonstrate the presence and extent of osseous bridging.\textsuperscript{10} Magnetic resonance imaging can also detect associated soft tissue injuries, including triangular fibrocartilage tears, scapholunate ligament or lunotriquetral ligament tears, cartilage damage involving the articular surfaces of the radius or carpal bones, and ganglia.\textsuperscript{3}

**Sonography**

Sonography has a limited role in the diagnosis of fractures. Hubner et al\textsuperscript{15} found that Salter-Harris type I fractures and nondisplaced fractures with less than 1 mm of separation could be reliably detected.
with sonography. However, complex fractures were found to be more difficult to assess with sonography.

**Management**

Treatment for gymnast wrist is conservative. Patients are treated with anti-inflammatory medications and should refrain from the inciting activity until the gymnastic maneuvers can be resumed pain free. Prognosis for Salter-Harris type I fractures is good if the germinal cells of the growth plate are not separated from the epiphysis and circulation is preserved. However, gymnast wrist can be associated with a risk of growth impairment resulting in a foreshortened radius, angular deformity, or altered joint mechanics at the distal radioulnar joint. These abnormalities can lead to significant long-term disability.

More attention needs to be directed toward prevention of injuries inherent to gymnastics, in which the upper extremities are transformed into weight-bearing limbs. Evaluation and recognition of gymnast wrist injuries can assist in formulating appropriate management for these patients because the compulsive and intense nature of many gymnasts can lead to recurrent or new injuries. More sophisticated and detailed examination of gymnast wrist should be done before onset of training, before increase of intensity of training, before competition, and with the onset of any symptoms, including observed guarding.

Pretraining and annual follow-up wrist radiographs may be considered for the skeletally immature gymnast, and follow-up evaluation after skeletal maturity and retirement from active participation will determine the long-term effect of gymnastics on the wrist.

**References**