How to Manage the Top Three Orthopedic Emergencies in Children

Distal radius fracture, radial head subluxation, and slipped capital femoral epiphysis are problems that nearly every emergency physician eventually sees in a young patient. Each has signal characteristics that point the way to speedy stabilization.

By Scott C. Sherman, MD, FAAEM

Nearly every active child breaks a bone or dislocates something at one time or another. Consequently, nearly every emergency physician eventually sees one of the following very common pediatric orthopedic injuries: distal radius fracture, radial head subluxation, and slipped capital femoral epiphysis. Recognizing the unique presentations and key diagnostic clues will ensure proper management, from simple and quick reduction to referral for speedy surgery.

DISTAL RADIUS FRACTURES

Distal radius metaphyseal fracture—usually due to a fall on an outstretched arm—is the most common fracture in children, accounting for approximately 20% of all pediatric fractures. The incidence has increased in recent years, possibly due to changes in activity patterns, reduced calcium intake, or both. Snowboarding, nonmotorized scooters, and soccer goalkeeping are all associated with higher risk.

Peak incidence is between ages 8 and 11 in girls and 11 and 14 in boys, which corresponds to the age in which bone growth is most rapid. In children younger than 3, child abuse should be considered.

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The clinical presentation varies, but the examiner may find gross deformity, crepitus, point tenderness, ecchymosis, or swelling. Grip strength is frequently reduced. Range of motion of the wrist may or may not be affected. A neurovascular exam should be conducted to help exclude concomitant injuries to these important structures. If the pain does not respond to medication, consider the possible complication of forearm compartment syndrome. Currently, there is no way to safely predict who will not have a fracture based on clinical criteria, so radiographs should be obtained in most cases of wrist trauma.

Distal radius fractures are classified the same way as fractures in the rest of the pediatric skeleton—buckle, greenstick, complete, or physeal. The pattern of injury affects treatment.

Buckle fracture. A buckle (or torus) fracture is a stable unicortical fracture caused by compression (see image on page 25). The most common location in the distal radius is the dorsal cortex. The volar portion of the bone is unaffected. Traditional treatment is with a forearm cast for three weeks. However, healing complications are so rare that a wrist splint or soft bandage has similar (even improved) outcomes, at less cost and with greater patient satisfaction.

In the emergency department, a splint is placed and the patient should be referred to a pediatrician for follow-up. Orthopedic referral is not necessary. Some authors suggest that the splint can be removed by the parents at home with no follow-up necessary. Repeat radiographs are usually unnecessary and a poor use of resources.

Greenstick fracture. A greenstick fracture entails complete fracture of one cortex and plastic deformation of the opposite cortex. These fractures have an angular and rotational component. Whether the fracture occurs at the distal radial metaphysis or the diaphysis, it is reduced by rotating the palm toward the deformity (dorsal fracture angulation requires

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pronation and volar fracture angulation requires supination) and applying pressure over the forearm in such a way as to eliminate angulation.

Complete fracture. A complete fracture of the distal radial metaphysis (see image on page 26) is usually managed without surgery, especially in younger patients. The distal growth plate of the radius accounts for 75% of the bone's growth; therefore, significant remodeling is the rule. If closed reduction is opted for, it is performed in a similar manner as with adults by an orthopedic consultant or the emergency physician. Because the pediatric skeleton has such a great ability to remodel, patients with 100% displacement that cannot be successfully reduced can still heal normally. Up to 15 to 20 degrees of angulation is also acceptable, and in these patients reduction in the emergency department is not necessary.

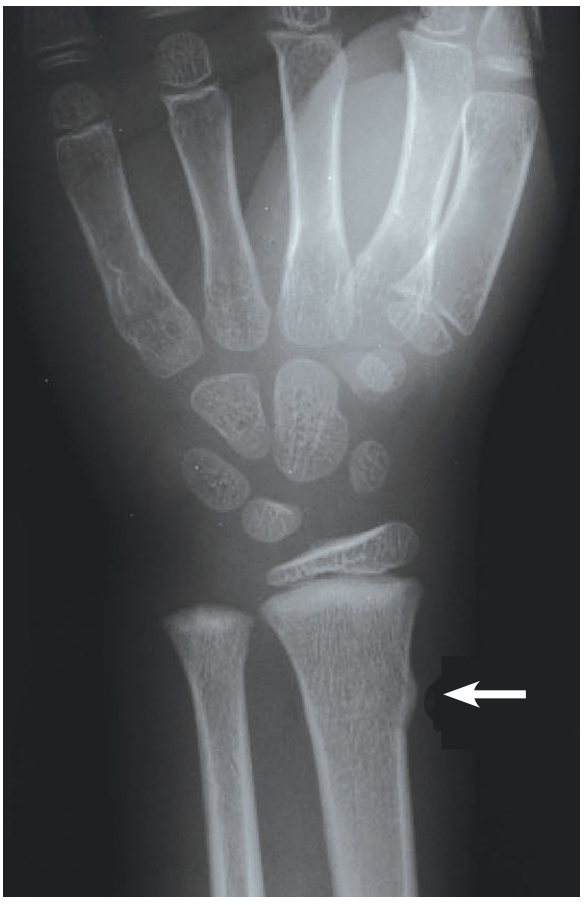
Whether manipulation is required or not, a sugar-tong splint is applied. Some orthopedists favor stabilization with Kirschner wires, even after a successful reduction. These authors cite a high rate of redisplacement requiring further reduction attempts as the major disadvantage to closed management.

Physeal fracture. The distal radial physis is the most frequently injured growth plate in the pediatric skeleton; such fractures account for 20% of all cases. Approximately 80% of injuries occur in children aged 10 to 16. A Salter-Harris type I fracture can easily be misdiagnosed as a "wrist sprain," since initial radiographs may appear normal or show only minimal epiphyseal widening or a positive fat-pad sign. Therefore, immobilization (with a volar splint) and referral are recommended in suspicious cases.

Salter-Harris type II fractures make up 30% to 60% of all epiphyseal fractures; 75% occur at the distal radius. When displaced, these fractures are reduced and immobilized. Remodeling is especially prominent in children less than 10 years old. The long-term prognosis for patients with a type II fracture is good. Salter-Harris type III to V fractures are associated with a higher rate of complications and orthopedic consultation is recommended.

RADIAL HEAD SUBLUXATION

Radial head subluxation—also referred to as nursemaid's elbow, pulled elbow, and temper tantrum elbow—is one of the most common orthopedic injuries in children. A busy emergency department will see approximately two cases per week. It is most common in children aged 2 to 3 (one study found it accounted for 63% of upper extremity injuries in patients younger than age 6), but has been reported in infants and older children as well.



>Distal radial buckle (torus) fracture. A wrist splint or soft bandage will often suffice for these stable fractures.

Mechanism of injury. The most common mechanism is a sudden axial traction on the extended, pronated arm when an adult lifts, swings, or pulls the child by the arm. The annular ligament surrounds the radial head. When it tears, it migrates into the joint space and becomes trapped between the radial head and capitellum. Radial head subluxation occurs only to the pronated arm because the transition from the neck to the head of the radius is more gradual when the arm is pronated,

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Because the pediatric skeleton has such a great ability to remodel, patients with 100% displacement can still heal normally.

>Complete distal radial metaphyseal fracture. This type of injury is usually managed without surgery.

allowing for the ligament to slide. This condition is rare in children older than 6 because the annular ligament thickens and is unlikely to tear. The left arm is more commonly affected, presumably because most adults will pull on the child's left arm with their dominant right arm. Bilateral involvement has also been reported.

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Although the classic pulling mechanism is responsible for half to two-thirds of cases, falls, twists, and unknown mechanisms can also cause these subluxations. In one common scenario, an infant's forearm gets caught between the torso and the floor when the child is rolling over, especially when aided by a "helpful" push from a parent.

Patient presentation. The child usually appears comfortable and holds the arm motionless at his or her side, slightly flexed and pronated (see image opposite). There is no gross deformity, swelling, or ecchymosis, but more than 60% of patients can't use the arm. Other complaints include elbow, wrist, or shoulder pain. Any of these findings may suggest an underlying fracture. With gentle palpation, slight tenderness can sometimes be elicited at the anterolateral aspect of the radial head. The child will vigorously resist any attempts at supination, although some passive flexion and extension can be achieved.

Radiographs. In most cases, radiographs are not indicated, especially if the presentation and physical exam findings are typical. They should be performed to exclude a fracture when there is significant tenderness, swelling, or ecchymosis, or the classic history is absent. (In radial head subluxation, the annular ligament is often reduced when the technician supinates the arm to take an anteroposterior film. If obtained, radiographs are usually normal. However, one report suggested that a careful examination of the radiocapitellar line will reveal the subluxation if it hasn't already been reduced. The radiocapitellar line is drawn through the center of the radial shaft and should intersect the middle of the capitellum.

Treatment maneuvers. One recent study of 501 children with this condition reported that 99.2% were successfully treated in the emergency department using one of several different maneuvers. The classic procedure involves supination followed by elbow flexion. The clinician stabilizes the child's elbow with the thumb placed over the anteriorly positioned radial head while holding the child's wrist with the other hand. Applying gentle pressure over the radial head, abruptly supinate the wrist, then flex the elbow.

In a 1975 study, supination successfully reduced the subluxation in 96 of 100 children on the first attempt. However, a recent direct comparison found hyperpronation of the arm was more successful. The first-attempt success rate was 95% for hyperpronation versus 77% for supination-flexion. The maneuver is similar except that the clinician "shakes hands with the child" and merely further pronates the forearm while the other hand holds the elbow and puts pressure over the radial head. Whichever maneuver is used, an audible or palpable click increases the likelihood that the reduction technique was successful, although a successful reduction may occur without hearing a click.

In my experience, the child will become upset following reduction because the procedure is momentarily painful, like having a Band-Aid torn off. It is best to leave him to be comforted by the parent, then return 10 to 15 minutes later to see if he is using the arm. Function does not usually return immediately because the child is reluctant to try using it, but most children will be able to use the arm in less than 10 minutes. If it isn't apparent that the procedure worked, offer a Popsicle, a sticker, or a toy to see if the child reaches for it with that arm.

If the child begins to use the arm, reduction was most likely a success; if not, repeat the reduction maneuver or try the alternate technique. If there is any question about the diagnosis, it may be prudent to order elbow radiographs at this time. Don't consider the subluxation irreducible until you have made a few fresh attempts every 15 minutes or so. In the rare event that a radial head subluxation is irreducible, apply a long arm splint and refer the patient to an orthopedist. Immobilization or use of a sling after successful reduction is not required.

Approximately 25% of radial head subluxations recur. Counsel the parent to lift the child from under the armpits and to avoid traction on the arm in the future. In addition, teach the parent the reduction technique to perform at home.

>Radial head subluxation. This common injury is often the result of discipline involving pulling, swinging, or lifting a child by the arm. The child usually holds the injured arm with the elbow slightly flexed and the forearm pronated.

SLIPPED CAPITAL FEMORAL EPIPHYSIS

Slipped capital femoral epiphysis (SCFE) is easy to miss and the consequences of an inaccurate diagnosis can be devastating. The key is to understand that SCFE often presents atypically. If you know the characteristic radiographic features and understand the various presentations, you will be able to make a prompt diagnosis.

The incidence of SCFE is approximately 10 per 100,000. It is most common in adolescents between 10 and 15, and more common in boys. In the United States, African Americans and Hispanics are disproportionately affected compared to whites.

A disorder of the proximal femoral physis, SCFE occurs when the femoral head is displaced relative to the neck of the femur. In some cases, the slip is rapid, while in other cases it occurs slowly over a period of weeks to months. Although there are many hypotheses, the etiology of SCFE is not well understood. Both mechanical (weight and hip geometry) and hormonal factors (endocrinopathy) contribute to the condition. It is strongly associated with obesity, with 95% of patients being considered obese or borderline obese. It is also more common in children with hypothyroidism, pituitary tumors, renal osteodystrophy, and Down syndrome. Approximately 20% to 60% of children with SCFE develop bilateral disease. A higher body mass index predicts involvement of both hips. In some cases, a traumatic event (such as a fall) precedes the symptoms.

Patient presentation. The majority of patients with SCFE complain of hip pain. However, SCFE can present atypically, resulting in a delay (on average, eight weeks) in the diagnosis in 30% of patients. The diagnosis is more commonly missed on the initial evaluation when hip pain is absent or when thigh pain is present. Pain in the thigh or knee or a limp in an overweight adolescent child should be considered SCFE until proven otherwise, even in the absence of hip pain. *continued*

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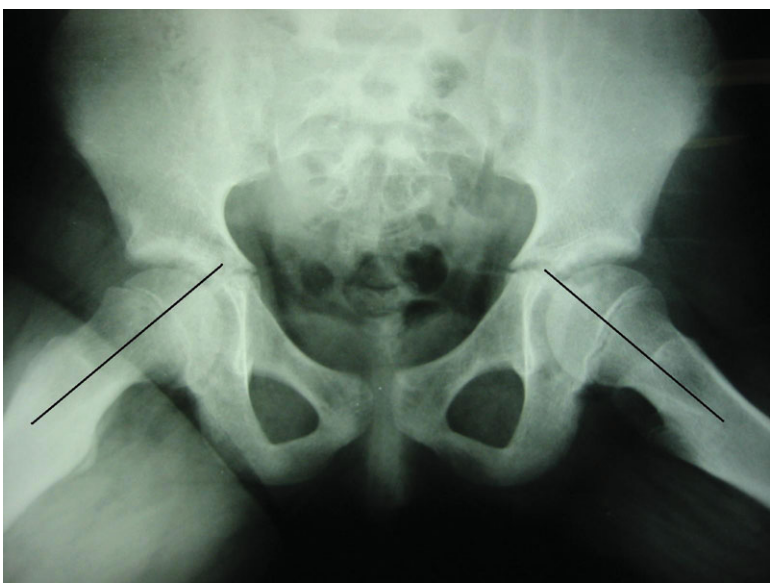
Slipped capital femoral epiphysis is most common in adolescents between 10 and 15, and more common in boys.

>Assessing femoral head position. An anteroposterior view of the hips is best for visualizing medial slipping in suspected slipped capital femoral epiphysis. A Klein line drawn through the superior portion of the femoral neck should bisect the same portion of the femoral head. In this radiograph, a subtle, mild, medial slipping is seen on the right side.



>Different perspective. A frog-leg lateral view of the hips in the same patient demonstrates posterior slipping. A line drawn through the center of the femoral neck should bisect the femoral head in a normal hip.

On physical exam, internal rotation of the hip is reduced or completely absent. Internal rotation is best tested by asking the patient to lie prone with the knees bent and then let his feet fall to the side. The degree of internal rotation can be compared to the other side. If the contralateral hip is unaffected, the difference will be apparent. Hip flexion will also be limited, and when the hip is passively flexed, it will rotate externally. Hip abduction is also limited, and there is often shortening of the affected leg.

Radiographs. Anteroposterior (AP) and frog-leg lateral views are indicated because medial slipping will be noted on the AP film, while a posterior slip (more common) is best seen on the lateral view. Both hips are viewed simultaneously for two reasons: Bilateral disease is common and subtle abnormalities may only be detected by comparing each side to the other. A shoot-through lateral should be obtained if the patient has too much pain to perform the frog-leg lateral. Be aware, though, that forcing the leg into this position may further displace the head.

On the AP radiograph, a Klein line is a line drawn along the superior aspect of the femoral neck (see top image). In the normal hip, this line intersects the femoral head. In a patient with medial slipping, the line intersects a smaller portion of the head or misses it entirely. Blurring of the proximal metaphysis—the Bloomberg sign—is consistent with early SCFE. The height of the epiphysis will be diminished if the femoral head is rotated posteriorly.

On the frog-leg lateral view (hip flexed 90 degrees and abducted 45 degrees), a line drawn through the center of the femoral neck intersects the center of the epiphysis in the normal hip. In SCFE, the line does not bisect the head (see bottom image). Because the lateral view is more sensitive than the AP view, it should be obtained in all cases.

Classifying SCFE. Traditionally, SCFE has been classified as *acute* (symptoms for less than three weeks), *chronic* (symptoms for more than three weeks), or *acute-on-chronic* (symptoms longer than three weeks but with a recent exacerbation). The problem with this classification is twofold. First, it is often difficult for the patient

and parents to accurately remember the duration of symptoms. Second, the duration of symptoms doesn't always predict the likelihood that the femoral head is mobile (that is, unstable).

In 1993, Loder proposed an alternative classification system to more accurately identify SCFE patients who might benefit from early surgery. In his system, SCFE patients were considered *stable* if they were able to ambulate with or without crutches and *unstable* if they could not. The presumption here is that when the head is freely mobile the patient cannot walk and will be in severe pain. In Loder's series, stable patients required reduction 8% of the time, had a satisfactory result in 96% of cases, and had a 0% incidence of avascular necrosis (AVN). In contrast, unstable patients required reduction 90% of the time, had satisfactory results in only 47% of cases, and developed AVN in 47% of cases. Further research has confirmed that the other major complication of SCFE—osteoarthritis—is more common in unstable patients.

Orthopedic consultation. In the emergency department, a patient with SCFE should be kept from bearing weight, and an orthopedic consultation should be obtained. Early surgical intervention prevents further slipping and associated complications, such as AVN and osteoarthritis. Patients with stable SCFE are treated with fixation using a single cannulated screw through the femoral neck and into the head. Patients are usually admitted but this may vary, depending on your institution. Surgery can be arranged on an outpatient basis only if there is unilateral involvement (the patient can use crutches), the SCFE is stable, and the patient and parents are reliable.

In patients with unstable SCFE, reduction and stabilization performed in a timely manner may prevent AVN. In a survey of pediatric orthopedists, 88% stated that for unstable SCFE operative repair should be performed emergently or urgently (within eight hours). Prophylactic pinning of an unaffected contralateral hip is not currently recommended in the United States. □

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