INTRO TO PEDIATRIC MSK RADIOGRAPHS: APPROACH TO WRIST RADIOGRAPHS

Developed by Dr. Kai Homer and Dr. Adrienne Thompson for PedsCases.com.
October 9th, 2023

Introduction:

Hi, my name is Dr. Kai Homer, and I'm a resident in Radiology at the University of Alberta. This video is the second in a series discussing musculoskeletal radiology in children. We're going to focus on musculoskeletal injuries and going through some cases to help you understand how radiology fits into the whole clinical picture. This first video will discuss terminology used to describe fractures in radiology, focusing on some concepts that are specific to pediatrics.

This module was reviewed by Dr. Adrienne Thompson, a pediatric radiologist at the University of Alberta. I'd like to thank the University of Alberta Department of Radiology for allowing access to images from real cases. All images have been de-identified and are used here for educational purposes only. These slides are available at www.pedscases.com and on the Canadian Association of Radiologists website.

After watching this video, the learner should be able to:

1. Identify the carpal bones individually on a radiograph
2. Recognize scaphoid fractures on a radiograph
3. Recognize the features of gymnast's wrist on a radiograph

This video is a case-based look at pediatric wrist injuries, and we'll work through three cases. Let's start off with the first case. A 12-year old boy is brought to the emergency department. He fell of the trampoline and now has significant left wrist pain and cries when you try to examine him. Radiographs of the left wrist are ordered. Here we have a frontal radiograph of the left wrist. Based on this one view there appears to be a transverse fracture all the way through the distal radius. If we look on this lateral radiograph of the left wrist, this view shows us that what looked like a transverse fracture does not quite go all the way through the cortex of the distal radius, confirming our diagnosis of a greenstick fracture. Greenstick fractures tend to occur on the side of the bone that was subject to tension forces, in contrast to buckle fractures which occur on the side that was subject to compressive forces. Let's say you're able to successfully reduce the fracture in the ED. Because these fractures can

become displaced and angulate again overtime, another x-ray at 1 to 2 weeks out is recommended to make sure alignment is intact.
Let's do another case – the following radiograph is of a 14-year-old males left hand. He fell off of a skateboard. He now complains of left wrist pain. You find tenderness at the anatomic snuffbox on exam. Let's quickly identify the carpal bones on this lateral view, so we've got the: scaphoid, lunate, triquetrum, pisiform, hamate, capitate, trapezoid, trapezium. And here they are all overlaid together. Here they are on the AP view: scaphoid, lunate, triquetrum, pisiform, hamate, capitate, trapezoid, and trapezium. We can also see the ulna, the radius and I've outlined the physes for both of those bones. So there's a transverse fracture of the waist of the scaphoid the fragments are separated by 1 mm. The remainder of the forearm, wrist and hand appear normal. Here's a different view called the oblique view - it's an additional view that's standard to get for suspected scaphoid fracture. It sometimes allows for better visualization of the fracture line which is seen in this case. A scaphoid series includes four views, a PA view, a dedicated scaphoid view, an oblique view and a lateral view. Back to the oblique view, the way that you tell that there's a fracture here is the radiolucent line running through the middle of the scaphoid that goes all the way across. So, that line that's a little bit darker than the surrounding bone (or a little bit more transparent looking) is the radiolucent line. Why do other fractures you may have seen look like clean, neat, black lines with two fragments on either side, but this scaphoid fracture line just looks like a slightly more radiolucent strip in the middle of the bone? When you shoot x-rays through the scaphoid, how white the bone ends up looking depends on how much bone the x-rays had to go through. The more bone, the more x-rays absorbed, therefore the whiter on the x-ray, because areas where all the x-rays get through without being absorbed are totally black like the space around the hand. These beams here in blue all go through an equal amount of bone, so the image that ends up getting produced all looks the same amount of white. Beams that go through the area of the fracture end up going through a mix of air and bone instead of just bone because they cross less total bone than the beams above and below, there's radiolucency, so more of the beams make it through to the detector than the beams that just go through the parts where there's bone but no fracture. If the x-ray beams went through the fracture dead on, at totally parallel angles we would see a pitch black fracture line, but because of the way the scaphoid's oriented it doesn't work out like that. The scaphoid has a tubercle, a distal part, a proximal part and a waist, and there's different surfaces on the scaphoid for articulating with various bones. In terms of epidemiology, the scaphoid is the most commonly fractured bone in the wrist. In terms of the mechanism, typically these fractures happen after falling on outstretched hand or wrist hyper extension injuries. The scaphoid, anatomically speaking, serves as a bridge between proximal and distal carpal rows. 70% of scaphoid fractures occur in the waist. Fractures proximal to the waist are at risk of causing osteonecrosis. The more proximal the fracture, the higher the risk. In terms of work up 2 to 5% of scaphoid fractures are not at all visible on initial imaging, so it's important to use multiple views to evaluate for a fracture. Because of the low sensitivity of x-ray at the time of injury in scaphoid fractures, if initial x-rays are negative, you should think about

getting a bone scan or MRI to confirm the fracture. Another approach is to immobilize the wrist and repeat x-ray in 7 to 10 days. For a suspected scaphoid fracture, the standard views to get are the PA and lateral, as well as a fancy pronated oblique view, often known as the scaphoid view. CT is much less sensitive than either bone scan or MRI for scaphoid fracture. MRI is a good test for scaphoid fracture because it can also look for soft tissue causes of wrist pain. Just to be clear, x-rays can show a scaphoid fracture a week after the fact, they just aren't great at picking them up when they just happened. As we all know, the dorsal scaphoid branch of the radial artery enters the dorsal side of the scaphoid and flows back proximally. The proximal pole is almost entirely dependent on intraosseous blood flow from that tiny artery, so a fracture such as the one this patient has can disrupt the blood flow to the proximal pole of the scaphoid and lead to avascular necrosis. Injury to the scaphoid and disruption of the surrounding ligaments, in particular the scapholunate ligament, may result in carpal instability. Scaphoid fractures are rare in kids, representing only 3% of hand and wrist bone fractures and 0.3 for 4% of fractures in total. Scaphoid fracture patterns in children and adolescents are similar to those of adults. We used to think that scaphoid fractures in paediatrics, as opposed to in adults, predominantly occurred in the distal pole, which meant that you didn't need to do anything to treat them. Research has shown that this is not entirely true, kids can get scaphoid waist fractures too, and can get complications like nonunion as well, so surgical treatment is sometimes indicated.

Let's do one more case. A 14-year-old female gymnast presents with chronic left wrist pain and tenderness. On exam, there's prominent swelling and tenderness around the distal radius. Here we have a frontal radiograph of the left wrist, and you will notice a widened distal radial growth plate. Notice the heterogeneous appearance of the bone that's enclosed in these boxes, alongside widening, there's irregularity of the physis. On the oblique view, you'll notice a band of sclerosis on the distal radial metaphysis. On the lateral view, the lateral radiograph again demonstrates the physeal widening and irregularities characteristic of this condition. Trauma-related osteolysis a.k.a. gymnast wrist is most common in teens around the time of puberty, and it’s most common in gymnast but has been reported in other athletes. It more commonly affects females. It presents with radial wrist pain that’s worse with dorsiflexion and axial loading. Symptoms tend to get worse after weight-bearing exercise. Chronic repetitive compression and torsion on the wrist in sports like gymnastics leads to inflammation of the physis, which leads to delayed calcification due to poor blood vessel penetration into the growth plate, which leads to a widened and weakened physis. This predisposes to further injury and fractured or fragmented metaphyses. If not treated this leads to premature closure of the distal radial physis, growth arrest of the radius, continued growth of the ulna, and ulnar positive variance, which ultimately leads to altered wrist biomechanics. Ulnar positive variance is when the ulna is shifted with respect to the distal radius. Complications of this condition include risk of early arthritis, tendinitis, ligamentous injuries, chronic wrist pain and triangular fibrocartilage complex injury.

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This concludes part 5 of this video series. In the next video in this series we will look at injuries in the pediatric hip. Before we leave, we wanted to leave you with a few key take home points

1) Be sure to check the distal radius for greenstick fractures on pediatric wrist radiographs
2) Scaphoid fractures are important to identify because of their risk of non-union
3) Widening of the distal radial physis is a feature of gymnast's wrist on radiographs

Thanks for watching part 6 of the pediatric MSK radiograph series on PedsCases, and please stay tuned for the rest of this series.

1. Little JT, Klionsky NB, Chaturvedi A, Soral A, Chaturvedi A. Pediatric distal forearm and wrist injury: an imaging review. Radiographics. 2014 Mar;34(2):472-90.

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