ICSC03-Section7-ElbowHandUpperExtremity

ICSC IMAGING Module 3
Section 7_ICSC03
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Video Lesson: 1:09:46

We are going to finish up Upper Extremity, covering the elbow, wrist, and hand. Let us start with the elbow and work our way down.

One of the important things when we are dealing with any kind of musculoskeletal trauma is we also want to make sure we are evaluating the soft tissues. We tend to focus on the bones, and look at the alignment, at the density and the cortices. But unfortunately, we focus so much on the bones, we tend to forget to look at the soft tissues. It is partially probably the fault of how we educate in that X-ray is predominately a bone technique. We want to make sure that we pay attention to the soft tissues because while X-ray is not great for soft tissue resolution, there are some very important clues that can be discerned by evaluating the soft tissues. In the elbow, there is a fantastic thing to do when we are evaluating the elbow. This view is looking at the fat pads. When we start looking at the average run-of-the-mill elbow, one of the things to keep in mind about the elbow is that there are two fat pads that we will see in an elbow. There is an anterior fat pad, and that anterior fat pad is going to be a dark little line that hangs like that. The second fat pad is the posterior fat pad, and we cannot see that fat pad because it is inside the olecranon fossa. What we are seeing is there is a sleeve of the joint capsule that surrounds the elbow joint, holds in the synovial fluid. When somebody has mild, moderate, severe effusion of that elbow joint, it is going to fill the joint capsule up with fluid. As it fills the joint capsule up with fluid, that is where we are going to start to see a displacement of these fat pads. It is one of those things that we always want to pay really close attention to.

When we look at this patient, what I am seeing in this person is the anterior fat pad is displaced outward. That is called the anterior fat pad sign. The other thing that I can see when I look at this patient is, on the back side, there is another dark line. That is called the posterior fat pad sign. So, anterior and posterior fat pads.

What fills up a fat pad or what causes this displacement? The first possibility is synovitis. You have something that is creating an inflammation of the synovial membrane and it is pumping a bunch of fluid into the joint as a simple bland joint effusion. We can see that in things like rheumatoid arthritis. We can see this in patients that have the inflammatory arthropathies. We can see this in some of the other inflammatory arthropathies like gout, CPPD. Some of those things will do it.

Because we are dealing with athletic injuries, not surprisingly we can see this with trauma. One of the things about those elbow fat pads is, when I see those elbow fat pads in a trauma circumstance, that tells me that there might be the possibility of a fracture. I have highlighted those anterior and posterior fat pads so you can see a little bit better. When we look at the fat pads in the elbow, one of the things we always want to think about is Sensitivity and Specificity. Understanding sensitivity and specificity of the fat pads. In order to displace the anterior fat pad, it only takes mild swelling. So, to take that fat pad from down here to out here where we are seeing it, it only takes mild swelling. If the swelling is mild, moderate or severe, it is going to displace that anterior fat pad. By the way, that anterior fat pad is also known as the Sail sign because theoretically it looks like a sailboat's sail that is full of air. Smile and nod. What that means is the anterior fat pad is very sensitive for an intracapsular fracture because if somebody has a fracture inside the joint capsule, they are going to have at least mild swelling. So, I can use that anterior fat pad and say, there is a possible fracture. It has high sensitivity but it has poor specificity because what if this person has a mild capsular sprain? What if they have got a grade 1 sprain of the radial collateral ligament? That can also cause a mild distention of the joint. If there is fracture, it will have an anterior fat pad. But if there is an anterior fat pad, it does not necessarily mean it is fractured.

The posterior fat pad sign, this one back here, is very specific. If I am in a circumstance of trauma and I see a posterior fat pad, the only way to get that fat pad out of the olecranon fossa where it should be and displace it all the way back to here is if there is severe intracapsular swelling. How do we get that kind of severe? Well, if there is trauma, this person definitely broke their elbow. If I do not see a fracture, it is still broken, and I have to

take some more x-rays. I have to think about some other imaging techniques to see what is going on. Posterior fat pad is very specific. Anterior is sensitive, posterior is specific. What are the things that might cause that posterior fat pad? Again, rheumatoid arthritis, gout, septic arthritis. Those are all the other possibilities. But when we are in that circumstance of we are dealing with the post-trauma elbow, I am really careful.

An important thing when we are dealing with an elbow x-ray, you do want to make sure that you get the elbow bent as close to 90 degrees as possible. That is the best way to be able to see those fat pads, realizing the limitations of dealing with the trauma case of how much they can move their elbow without screaming and clearing out the waiting room.

In this particular case, I will give you a second to look it over. I am going to go back up one picture. There is all the arrows and moving things out of the way, look at the X-ray, we know that this person has anterior and posterior fat pad. There is a need for capsular fracture until proven otherwise. See if you can find the fracture in this case. By the way, this is my favourite game. It is “Where is Waldo” of the radiology world? My children never got to play “Where's Waldo”? My children got to play, "Hey, find the fracture,".

As we look at this one, we trace the radial cortex around. There is the start of the articular surface, then the articular surface divots down there, and there is the remainder of the radial head. This person has a displaced radial head fracture. It is not always easy to see because there is a lot of overlapping structure there.

Now that we have started the idea, we are going to look at the bones, we will also look at the soft tissues. One of the things that radiology runs on is statistics, understanding what is the most common. We are going to see most common things more often than we are going to see less common things. You always want to keep the zebras in mind. Beyond zebras, there is unicorns. Beyond unicorns, there are pegasi. You want to keep all those things in mind but when I hear hoofbeats, I think horses not zebras. Do things break around an elbow? Well, the answer to that question depends a lot on the patient. If we are dealing with children, children have elbow trauma and elbow trauma can be direct elbow trauma or it can be a FOOSH. We can see supracondylar fractures most commonly. They will fracture the humerus above the condyles. Then, there are condylar and epicondylar fractures. In the adult, as our bones become more rigid, less plasticity than we see in children. What is the most common mechanism? FOOSH. What is going to happen? When you FOOSH, you load your thenar, thenar loads the carpals, loads the radius, drives the radius into the capitulum.

A really important concept in the physics of fractures is concave versus convex structures. If we look at a radiocapitellar joint, radius comes up. Not the world's greatest radius, and then the capitulum. I realize this looks like a presynaptic and postsynaptic axon as well. When we look at this, one of our huge concepts in trauma is if there is a longitudinal force across the joint and a concave surface is meeting a convex surface, the convex surface usually wins. There is an inherent strength in convexity. What that means is the capitulum is usually going to be okay, it is the radial head and neck that is going to have the problems. In the adult patient, the most common fracture around the elbow is radial head and neck. We can either see where it splits the radial head like cord wood or it impacts the radial head on to the neck. Otherwise, other things we will see in adults: olecranon fractures, supracondylar fractures, and there is a bunch of forearm fracture dislocation that we need to be aware of.

Starting off with children, the supracondylar fracture. As we look at this patient, it is subtle but there is a posterior fat pad in this case. Right through here, there is a little darkness, that is the posterior fat pad. When I am looking at a pediatric elbow, we know the children are a pain. There are extra growth centers, there is some things that haven't developed yet. When we are looking at the elbow, there is even a mnemonic as the different growth centers show up at different ages. The mnemonic for remembering that is CRITOE, capitulum, radial epiphysis, and so forth. Do not forget when you are dealing with pediatrics, one of the things you can do when you are dealing with pediatric patients is you can always X-ray the other side. When we are dealing with extremities, we are not worried about radiation exposure to the extremities. There is nothing reproductive or anything damaging in the extremities. So, if I have got a child and I am looking at a right elbow and I am not sure if that is what it is supposed to look like and I do not have a pediatric radiology textbook available, X-ray the left elbow, compare the two sides. I do not do this on every child on every extremity. If I am not sure what is going on, please do not do this.

As I am looking at this child, there are extra missing parts, the AP was unremarkable in this case. One of the things that we will want to do, there is a line and surprisingly, this is a line that has a name that makes sense. This is the anterior humeral line. The anterior humeral line should intersect approximately 50% of the capitulum. As I look at the capitulum in this child, there is the capitulum, it is only getting about 30%, because what happens when we deal with supracondylar fractures, the supracondylar fracture, this is a fracture line through there. Because this typically happens with a FOOSH, as the radius impacts and the ulna impacts under the capitulum and trochlea respectively, it pushes them posterior. So, we are going to see that posterior angulation that occurs in the child that has the supracondylar fracture. This is the very much the average run-of-the-mill supracondylar fracture. Of course, there is always the much more apparent jump-out-and-grab-you fracture.

I do not think I really need to do the anterior humeral line in this particular case. This is a child whose athletic event was jumping off of the top bunk, and in jumping off the top bunk and landing on their outstretched hand, ended up with a very significantly displaced supracondylar fracture. This is the child that you are going to see wearing an elbow cast. They will have the cast from the armpit to the wrist set at 90 degrees as they work on reducing this fracture.

What else can we see broken? I probably should have put the radial head as the next one, but I did not. The next fracture, and this one we tend to see more in adults than we do in peds, which is, of course, why I have thrown up a pediatric case. But there is a nice fracture of the olecranon. How do you fracture the olecranon? Smack it. This is a simple direct trauma. When somebody is falling, if they do not catch themselves on their hand, they catch themselves on the elbow. We can see it with anything where an elbow goes against structure. One of the big clues, typically, when we are dealing with the olecranon fracture is the person is completely unwilling to forcefully hyper-extend their elbow, they are not willing to muscle test into elbow extension because the triceps is pulling against that.

In more severe cases, we can actually see where the fragment will displace and the person loses all triceps mechanism so their arm actually telescopes up and they actually cannot extend their arm because they do not have that extensor mechanism anymore. Quite often, when we start looking at these, these will require open reduction internal fixation, and what they are going to do is drive a screw through the olecranon and into the rest of the ulna.

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What else can we break? The adult patient who FOOSH is typically going to fracture, and they have elbow pain. Does my shoulder, elbows or wrists hurt? Different fractures. Person FOOSH and they have got radial head tenderness. You start digging in there, they start wincing. Let us get some pictures. An important thing to remember in dealing with the adult that has post-traumatic elbow pain, think about elbows. Elbows are usually a two-view X-ray. There is an AP View and there is a 90-degree lateral view.

When I have the adult patient who has post-traumatic elbow pain, I am going to do three pictures. One more picture that I am going to throw in. The standard AP is done like this. The hand is nicely supinated. I am also going to do a hyper-supinated AP view. Then I am going to rotate the whole patient. I need the rotation to come out of the humerus in this case. What I am doing is I am projecting the radial head free of all the other structures. This is a lateral oblique because the problem is on a straight on AP, there is quite a bit of overlap between the radius and the ulna, and that is usually where the fractures are going to hide.

With these radial fractures, we are going to see generally two fractures. The one that we are seeing in this particular case is right through there. It is where the person has split the head. This is called a chisel fracture because the convex capitulum against the concave radial head, that acts like a chisel and it splits the radial head, again, like cordwood. If you are around anybody who is doing lumberjack style games, splitting like cordwood.

The other possibility when we are dealing with the radial head and neck is the possibility that right at the head-neck junction, you can see an impaction. This where really getting the radius flat is important. I have somebody who has elbow trauma, they do not want to fully extend their arm. I realize you might do two APs, you might do

an AP with the humerus on the table and then you will do an AP with a forearm on the table because you are trying to get nice frontal appearances for both sets of bones. Look for that area of impaction where there is a cortical offset. There can also be an extra dense white line right around the zone of impaction. That is the zone of impaction.

What is interesting is if they are not displaced, when we look at the chisel fractures and the impacted neck fractures, they are generally handled conservatively. This person needs to go into a sling and given time to heal, then gradual reintroduction of motion fairly early on because one of the things that can happen in a mobilized elbows is it is possible for the elbow to freeze.

Some of the other elbow fractures that can happen. There is a couple of different possibilities when we start looking at capitular fractures. We can look in this person. We are looking at the AP and the lateral. We can see that there is this irregularity of the articular surface of the capitulum. Three different diagnoses here: osteochondral fracture, osteochondritis dissecans, Panner's disease.

An osteochondral fracture is a traumatic fracture. Usually, what is happening here is something created a tangential force where the radius is shifting. So radial head has that concave, the capitulum has the convex. Normally, we think about the impaction in that fracture of the radius. The other thing we can see is a tangential force where the radius is sliding against the capitulum, and if that happens, that can shear off a piece of the articular surface. That is an osteochondral fracture. Usually, a single traumatic event.

Possibility two, Osteochondritis dissecans. This is a cumulative repetitive trauma that we typically see in children that are doing any kind of valgus force. Winding up for pitching and then pulling through creates a huge amount of valgus force and that repetitive valgus force in the elbow as it loads the radio capitellar joint can result in mechanical failure. It is very similar in nature to a stress fracture. We are going to talk a lot about stress fractures when we get into lower extremity.

The other possibility is Panner's disease. This is a true avascular necrosis. It is where the capitulum loses blood supply for whatever reason. It can be a single event; it can be cumulative stress. With avascular necrosis, we start to see sclerosis, flattening, and fragmentation of the articular surface.

There is a continuum here. There is a lot of questions of where do we stop calling osteochondritis dissecans and where do we start calling Panner's? There is a little bit of an iffy thing here. One of the take-homes on this though, particularly, is we are dealing more with the adult and the osteochondral fracture. Realize that when we are dealing with a lot of osteochondral fractures in the adult patient, one of the questions is surgical versus conservative management. One of the ways that question is asked is by doing an MR arthrogram because the concern is, is the fragment stable or not? If the fragment is unstable, then it is going to have to be surgically pinned in place or removed. If the fragment is stable, it is probably going to heal in-situ. That is a question that is going to be asked depending on what you are allowed to order. If you have a good relationship with your orthopedist and you do a lot of your triaging, you might end up getting that MR arthrogram before they go to the orthopedist.

Other things that can happen in the elbow, getting back into the pediatric elbow. Looking at pediatric pitching sports, baseball. One of the things when we start looking at pediatric baseball in pitchers… one of the things that pitchers are not allowed to do in American Little League, is they are not allowed to throw curve balls because in order to get a curve ball, it requires a really big valgus wind-up and a huge flexion mechanism through the wrist. Between the valgus pull in the elbow and the flexion in the wrist, that can create an avulsion of the medial epicondyle of the humerus. It is common in Little League. It is called Little Leaguers' elbow. Quite often, this is going to require surgery to reduce this. This will also frequently have associated injury to the ulnar collateral ligament.

Typically, we only see these avulsions in children. Once children hit skeletal maturation, they usually just damage the ulnar collateral and that is where we can start seeing Tommy John Surgeries done. Again, the question does roll in. Where is the trochlea? That olecranon does not look like it is very deep. Is that really supposed to be out there? I am not sure. If you are not sure, X-ray the other elbow. Use it as your normal

template, because typically, they are not going to be pitching with both hands. We will be able to look at this and figure out, is this where it is supposed to be?

The other thing that you can have available to you is a good pediatric resource. If you are going to be doing a lot of pediatric athletic events, you have your own X-ray equipment. You are looking at a lot of pediatric X-rays. Having a pediatric radiology textbook is incredibly valuable. Some of the different books that are available. One of the ones that is really designed for the clinician is John Taylor's Skeletal Imaging: Atlas of the Spine and Extremities. At the beginning of every chapter, it shows you normal pediatric development. If you are hardcore into pediatrics, that is where something like Caffey's Pediatric Diagnosis, it is a radiology text, is a useful thing to have in your library. We can see that avulsion and this one has enough displacement where the orthopedist is going to be considering tacking that back into place.

What else can happen to the elbow? Dislocations. This can be a FOOSH injury. This can also be where you get direct elbow trauma into the antecubital fossa because almost always the elbow dislocates posteriorly, of course, named for the distal component. This is a person that has a posterior elbow dislocation and not surprisingly, it tends to lock in this location. It is not one of those ones that will spontaneously reduce. One of the concerns being, if we see this sports field side, we know that we are going to immobilize the patient and get them off to the emergency department.

Maybe two weeks from now, I get this athlete who comes into my office complaining about elbow pain after they had the reduced dislocation. Particularly if you are getting some locking or grinding, one of the questions that I would want to ask at that point is, did this person also fracture their coronoid? It happens with the dislocation. They can fracture off the coronoid, or as it is being reduced, the coronoid can fracture and trap inside the joint. Those are some of the complications that are associated with that.

The other thing we are not surprisingly worried about is neurovascular bundle damage. Could this create some displacement in the brachial artery? If I think about the fact that the ulnar nerve is traveling right through here, if this thing goes posterior, there is a lot of soft tissue injury, and it might have stripped the ulnar nerve out of the cubital tunnel there. I am going to be evaluating this patient very carefully for, the vascular component is usually immediate onset. The neural component might be something where, you have got a little palsy going on. Right afterwards, let us give it a chance and see how it does. Two weeks later, come in to see us. Let us evaluate that ulnar nerve.

We cannot talk about elbows without talking about the possibility of epicondylitis. Should we be calling it epicondylitis? Is there an inflammatory component? No. We should be calling this epicondylosis. That just does not roll off the tongue quite as well. There is both medial epicondylosis and lateral epicondylosis. Medial epicondylosis: Golfer's elbow in an adult; in a pediatric patient, Little Leaguer's elbow. Of course, there is all the orthopedic tests. I am not going to get into the orthopedic tests. That is more for the clinical diagnosticians. Then there is lateral epicondylitis, which is a whole heck of a lot more common than medial epicondylitis, and this goes by the colloquial term of Tennis elbow. Anybody who is doing any kind of extension activities with the wrist has the possibility of creating that problem with the elbow.

I am generally not doing imaging for these. Golfer's elbow and tennis elbow are clinical diagnoses. Little Leaguer's elbow, I am going to be pretty liberal about X-raying the child to see if there is displacement there. But the adult patient, I am going to treat this clinically. I am going to see how well you do. It is not a difficult diagnosis to make. Poke it, see if it hurts, do some orthopedic testing and some stretching, confirm your diagnosis, and treat the epicondylosis, the tendinosis that goes along with this. We will generally reserve imaging for the patients who do not get better. That is where we start to see the imaging done for patients with epicondylitis/epicondylosis, because one of the concerns, particularly with tennis elbow is, particularly if there is a traumatic component to this, is there a tear? Did they also damage the radial collateral ligament? Then I would start considering doing some imaging. Again, ultrasound is a fantastic tool for this, or I would be more MR centric, so I would tend to go towards MRI.

Looking at an MRI, we are looking at an elbow. This is a patient who had a traumatic injury to the elbow, not responding to the conservative care. The question then was, is there something more than just a simple

tendinosis going on? Now, when we are trying to evaluate tendinosis, for the common extensor tendon, the coronals are where we are going to spend most of our time, and particularly if we have something that is fluid-sensitive, so a T2, a STIR, a gradient echo, and in this case, we are looking at a coronal gradient echo. Now the arm is forearm up, arm down. We are seeing the ulna there, getting into the humerus here, radial head here. We can see through here, there is the ulnar collateral ligament. There is the ulnar collateral, and as I am looking on the radial side, I am seeing a lot of fluid on the radial side for one thing. I got to dim this down a touch. There is quite a bit of fluid. I am looking at that common extensor tendon. It is not the thick belly tendon that I really expect it to be. I can see there is quite a bit of irregularity, and then deep to the common extensor tendon is the Radial collateral ligament. The Radial collateral ligament in this patient is Grade 2 sprain. This one here is not a complete rupture, but there is a grade 2 sprain of Radial collateral superimposed on that tennis elbow. So those are some of those things, when we start thinking about imaging, the trauma patient that is not responding or we are concerned about internal derangement.

Other things that can happen around the elbow is biceps tendon, which is a big one. This is something that we see in heavy weightlifting activities. It can happen during the concentric phase, but really, most of these tendon injuries happen during the eccentric phase where the person's extending the elbow against weight, and suddenly, they hear a pop, immediate onset of pain in the elbow, and generally, within 10 minutes, the entire antecubital fossa and leading up into the upper part of the anterior bicep is just turning bright purple as the person is hemorrhaging into that area when that biceps tendon tears. Again, not usually very difficult to diagnose clinically, but one of the reasons that we run imaging on knees is how far is it from the tendon tear to the attachment? Because that might decide is this going to be conservative management with bracing or is this going to be operative management to try to reattach that tendon? This is very athletes specific. What kind of sports are they doing? What level are they at? Can really dictate exactly what is going to be happening when we are dealing with that. Ultrasound is an option and will show us the biceps tendon, effectively. I tend to be more of an MR person because it is less operator dependent and more universally read, particularly by our orthopedic colleagues when we are doing these things.

Video Placement Presentation: 30:46

Let us look at this elbow MR. I am going to run through a couple of different sequences as we look at this one. Now, when we are dealing with any of these extremity joints, again, we are seeing T1s, T2s, where there may or may not be fat suppression, there may or not be gradient echo sequences. My general rule is anytime I am looking at an MR, I always start on a fluid sensitive sequence because I am looking for something that is angry. I am looking for angry tissue. An angry tissue is usually inflamed tissue. It is going to show up bright when I look at those fluid-sensitive sequences. And on this one, I have got three options for fluid sensitive. There is an axial T2 with fat suppression, there is a coronal proton density with fat suppression, and there is a sagittal proton density with fat suppression. I am going to start with the sagittal PD fat-sat.

I am scrolling in. It is not too hard to figure out whether you are medial or lateral because all you need to do is figure out do I see radius or ulna? I am looking at the radiocapitellar joints, and I am noticing in through here in the region of the antecubital fossa, there is quite a bit of fluid. The stranding that I am seeing here, that is normal blood vessel, but this is soft tissue edema. Then as I am coming over into the olecranon, there is the triceps. We were talking before about triceps or olecranon fractures can take away the triceps mechanism, especially when the fracture is right through there. There is the coronoid. Nothing else really adenomatous.

I look at the coronal. We are starting in the front and working our way back. There is a substantial degree of soft tissue edema right in through here, and then follow the biceps, that is where the axial is going to play the biggest role. I am going to pull our two up window on this one. I like to start in the humerus and work my way down, because realize there is two different muscle groups we are going to be looking at. We are going to see brachioradialis and we are going to see biceps. The easiest way to figure out which one is which, come down to the elbow, find the ulna, find the tendon that comes into the coronoid process, follow that up. And that tells me that this muscle bundle here is brachialis. This muscle bundle here with this elongated tendon, that is the biceps brachii guy. Here's the biceps tendon, and it is starting to dip down and we follow that tendon in, and all of a sudden, there is a huge amount of fluid, and we are seeing where there is this continuity through this tendon.

So, right in through here, this has become this discontinuous with the radial tuberosity. This person has a biceps insertional rupture. There is no significant retraction. It is very much approximated. That will help the orthopedist with that decision of conservative versus surgical management. One of the big take-homes, always start off on your fluid sensitive sequences, looking for edematous issues. We can see the same thing if we follow that biceps tendon through here. You can see how it got really thick, and then it never really plugs into the radius.

We are finished with the elbow, now we are going to get into the forearm. When we start looking at the forearm, one of the things that we need to keep in mind, and it plays a role in pelvic trauma, it plays a role in leg trauma, and it plays a role in forearm trauma, is something called the Pretzel principle. When we start looking at a hard pretzel, yeah, good Bavarian hard, crispy pretzel. It is hard to break a pretzel in just one place. Where this applies when we are dealing with ring structures because pretzels are ring structure, so you cannot break it in just one place on the ring. Well, the forearm is the same thing. Between the ulna and the radius and the distal radioulnar joint, the proximal radioulnar joint, that makes it ring. One of the things we have to consider is anytime we are in a ring structure and there is a disruption one place in a ring structure, we always have to look for a second disruption or even more.

We are not pretzels, it is possible for us to break a ring in one place but always make sure you look carefully around the rest of the ring. This is also known as the Life Saver principle. If you think Life Savers candy, little circular candies, cannot break them in one place.

We start looking at forearm fractures, the first of the forearm fractures is the Nightstick fracture. This one is a direct trauma, something simple and straightforward. Something hits the person on the forearm, and it is very common when we are dealing with martial arts we are looking for blocks and things of that nature. Well, tibia versus ulna. I wonder which one is going to win. We see this with a direct blow, and that direct flow fractures the ulna. This is either known as a Nightstick fracture or as a Parry fracture because you are trying to parry the blow away from you. But I want to make sure I look carefully. I am going to check the radius, the distal radioulnar joint, the proximal radioulnar joint, looking at the elbow, looking at the wrist.

This is a huge, massive rule in radiology. When you are looking at long bone studies, you are looking at a humerus, forearm, femur, leg, you have to make sure you include both joints. If you do not include both joints, that does not meet minimal diagnostic criteria. If I am worried about forearm and it is a midshaft forearm issue, I need the wrist and elbow, otherwise, I am going to be missing things. What I am concerned about is the ulna fracture which jumps out at me. Let us look for some other fractures. In this case, we are seeing that ulna fracture, with the ulnar fracture jumping out at you, note the massive displacement here.

It is not uncommon to see that Bayonet apposition occurring as there is some unopposed muscular action going on, and we might hit satisfaction to search, where? I see that and I stop looking. Well, the problem is when you stop looking you miss the fact that the radius is no longer articulating with the humerus. This is a Nightstick variant, there is a Nightstick fracture of the ulna, but then there is dislocation of the radial head, and that is called a Monteggia via fracture dislocation. A big one for you to be aware of. Sometimes you will see it called fracture, sometimes fracture dislocation. I usually call it Monteggia injury, just to encompass all those different parts.

The concern here is, the ulna fracture is going to heal fine. We reduce the radius, there is going to be ligamentous injury. But keep in mind, how is the interosseous membrane? That is something that is going to be injured quite often when we start dealing with these cases.

This next one, the Galeazzi fracture, also known as a Piedmont fracture. This is one where we are seeing a radial fracture. The radial fracture tends to jump out at us. The problem is on the frontal view, it is subtle. It just looks like the person has a positive ulnar variance, but what they have is a dorsal dislocation of the head of the elbow. The distal radioulnar joint has been dislocated. The fracture is easy to see, the dislocation might be much more

subtle, and again, what is the integrity of the distal radioulnar ligaments? How is the triangular fibrocartilage in this person? How is the interosseous membrane? Those are all things that can really be very slow to heal.

Then we come to Essex-Lopresti. With the Essex-Lopresti fracture, notice all these forearm fractures start to sound alike and run together. What we are seeing with an Essex-Lopresti is this is a patient who has a proximal radial fracture and then distal radioulnar dislocation because what happens is with a comminuted radial head neck fracture or an impacted fracture, it shortens the radius. As it is shortening the radius, it creates damage to the distal radioulnar joint. You can see where this person has a post-traumatic positive ulnar variance. This person also has a couple other things going on. Like they have an old die-punch fracture, which I am not going to get into in this class.

Then, we must deal with pediatric fractures. We cannot discuss injuries without talking about pediatric fractures. Children' bones are plastic. Because children' bones are plastic, they can get more deformation than they do failure. When we deal with children, there are two major incomplete fractures due to that bone plasticity. The Torus fracture and the Greenstick. This child, was unlucky enough to get both. When we look at this child, probably FOOSH, the most common mechanism, they might have had an angular force come across the forearm. What we see when we look at the radius, notice that there is a fracture that goes about halfway through the bone and then starts to split longitudinally. That is called a Greenstick fracture. It is called Greenstick fracture because if you cut a branch off a living tree, and then you bend it to try to break it, it does not usually break all the way through. It breaks halfway through and then splits longitudinally.

The other fracture that we see right here is called the Torus fracture. The Torus fracture is an impaction injury. The bone is loading, and as that bone is loading, it gets a plastic deformity. We are going to see buckling in the cortex. One of the other names for Torus fracture is a Buckle fracture. This one is not named in a way that makes nearly as much sense unless you are really into Greek architecture. The Torus is the little rounded flare at the top and bottom of pillars, so we are seeing a little rounded flare right there as an indicator of a Torus fracture.

We need to get a little bit further down out of the forearm proper and more in towards the wrist, which is going to bring us to a whole bunch of fractures. One of the things you will notice with the wrist and the hand. There are a bunch of named injuries when we look at the wrist and hand. Because we were just talking about pediatrics, I want to continue our pediatric discussion.

When dealing with pediatric injuries, there are a couple things you should note that is different from adults: Pediatric injuries have hopes, dreams, and the big one they have growth plates, and growth plates are very susceptible to injury. These injuries are called Salter-Harris injuries. The fracture involves the growth plate, the physis. These are sometimes also called epiphyseal fractures. I am not super fond of them being called epiphyseal because the epiphysis is a specific part of the bone, the physis is the growth plate.

We are looking at these physeal fractures, Salter-Harris classification. There are five different types of Salter-Harris fracture. There is an expanded version of the Salter-Harris fracture classification. We are not going to get into that. That is kind of subtle and rare kind of injuries. Now, with the Salter-Harris classification. There are five Salter-Harris fractures. The fracture involves just the physis. It involves the metaphysis and the physis, the epiphysis and the physis, both metaphysis, epiphysis and physis, and then the crushing injury.

Now the type 1 Salter-Harris fracture. When we are dealing with peds and we are dealing with upper extremity, the type 1 Salter-Harris fracture that we are probably going to see more than anything else is the Gymnast fracture. There is a couple of different manifestations. The first is why is it called a Gymnast fracture? Because they spend a lot of time landing on their hands. Name a sport where people intentionally FOOSH more than gymnastics. So as a combination of just landing on their hands that loads that growth plate. And we can start to see widening of the growth plate, irregularity of the growth plate and a lot of distal radial tenderness. Particularly, you can think about things like handsprings where your hands are going down, but there is a rotational force around the wrist that can shear through the growth plate. And then we can see a growth plate displacement, which is exactly what we are seeing here.

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In this case, if you look at the ulna, so metaphysis, physis, epiphysis. We do not see that same relationship in the distal radius because the epiphysis has fallen off the metaphysis. This person fractured right through the growth plate, and then they had posterior displacement. Not surprisingly, we do not see the fracture line because well, the physis is made of cartilage. We do not see the fracture line, but we might see displacement or widening of that physeal plate. Type 1 Salter-Harris fracture, distal radius, that is the gymnast's fracture. We are going to see another very common type 1 Salter-Harris in the lower extremity when we talk about slipped capital femoral epiphysis.

The type 2 Salter-Harris fracture, as we look at, the pediatric patient, lots and lots of growth plates. But as we are looking at the third digit, notice that there is a fracture through the metaphysis that hits the growth plate. As soon as the growth plate gets hit, that is a Salter-Harris fracture. This one has the metaphyseal component. This is a type 2 Salter-Harris fracture. The type 2 Salter-Harris's the most common type. This one's a little bit more subtle. This one is a little bit more overt. See quite a bit of displacement between the metaphysis and the epiphysis. And this person left little metaphyseal corners. Technically, these little corners have a name called Thurstan Holland fragments. We just call these type 2 Salter-Harris fracture to keep life easy.

Type 3, the fracture goes through the epiphysis, and then hits the growth plate. We can see in this case, on only one view, do not see anything on the straight on AP, do not see anything on the lateral. But on the medial oblique, there is a fracture running through the epiphysis that hits the growth plate and is running laterally here and it is separating this fragment. This is a type 3 Salter-Harris fracture.

The type 4 Salter-Harris fracture involves both metaphysis and epiphysis. On the frontal view, we can see the epiphyseal component. Right now, this just looks like a type 3. But then when I look at the lateral, I see that there is a metaphyseal spiral fracture coming down to the growth plate. So that looks like a type 2, and this is one of those interesting instances, where a type 2 plus a type 3 equals type 4. There is a metaphyseal and an epiphyseal component, so that is a type 4 Salter-Harris fracture.

Then the type five is a crushing injury. We look at this child and we know that this child jumped off something landed really hard, and they fractured their calcaneus. We will talk about those in the next section. But this child is having a lot of tenderness along the tibial growth plate. The problem with a type five Salter-Harris, radiographically normal because you cannot see the crush in most cases. You must get the history. They will have tenderness along the epiphyseal plate. One of the clinical rules is if there is tenderness along the epiphyseal plate, it is broken, even if the X-rays are normal, it is broken. And the problem is that crushing injury or any of these growth plate injuries can affect the way that the bone is going to grow. We want to make sure we keep those Salter-Harris fractures in mind. You realize I have given you a lot of lower extremity examples. Not surprisingly, they are more common than upper extremity.

What else can we injure in the upper extremity? Well, FOOSH injuries. When we start looking at FOOSH, person that goes FOOSH. In this individual, this was not a sporting injury, this was a home-based injury. But this is one where it is not difficult to clinically make a call that this person has a fracture because we are seeing something called a dinner fork deformity, where the arm is bent backwards there at the distal radius. When I see that dinner fork deformity in an adult, I know that I am most likely dealing with a Colles fracture because it is the most common fracture to happen around the wrist in a geriatric population. Little children tend to get Torus fractures, the radius. Anybody from 15 to 40, 50, they tend to fracture the scaphoid. Over 50, that is where we tend to see colles fractures. Typically, because it is due to a change in the bone density. This is the same patient. We can see where there is posterior angulation of the distal radial component with that colles fracture. So colles as opposed to angulation.

There is also something called a reverse Colles, otherwise known as Smith's. This is where there is volar angulation. This happens in one of two different ways. Possibility one, the person falls on a flexed wrist, or if you fall backwards. The vectoring is such that it creates a volar force, and we are seeing that anterior angulation of the distal radius. Something else to note on this one is this person did also fracture their ulna styloid. Ulna styloid fractures are very common. It is like an add-on. You will see it with colles, Smith's, Barton's and all these

other fractures that will often fracture the ulnar styloid. If that fractures, then we must worry about the integrity of the triangular fibrocartilage.

Our next fracture is the Barton's fracture. Not surprisingly, also a FOOSH mechanism. What happens in this case, as the person is landing on that extended wrist, the carpels are going to vector this way. And when they do, they can fracture off the posterior rim. That is what we are seeing right through there. I usually call this Barton's posterior rim fracture to make life easy. The concern when we see the Barton's fracture, If the fracture is by itself, it is not that difficult, it is not that big of a deal. The problem is what often happens once Barton's fracture happens, the carpals dislocate. It is very common to see a posterior dislocation of the carpals in association with a Barton's fracture.

let us be honest, this is a subtle injury in this case. What would make me concerned that I am looking at somebody that has a fracture? I am seeing distension of the pronator quadratus. Put that together, and it is the quadrator. The pronator quadratus fat stripe is being displaced, which is a good indicator of trauma to the area. I know that this is going to make me sound like a nerd, but realize that every radiologist has a favorite fracture, just like every orthopedist has a favorite fracture. My favorite fracture is the radial styloid fracture, and it goes back to being a car person. Because if we look at old school vehicles, 1930s, 1940s, realize starters didn't exist back in the day. In order to start the vehicle, you had to stick a big S-shaped crank into the front of the engine, and you had to manually crank the engine to get it to start. Very much like you see with lawn mowers where you pull start, just a much bigger version.

One of the problems is when you are cranking the engine, sometimes the engine would backfire and it would spin the crankshaft backwards, and when it did that, if that shaft spins backwards, it would come back and hit the person across the radial styloid. That creates what is known by a bunch of different names: Radial Styloid fracture, Chauffeur fracture, because well, hopefully, that is who was starting your car, Backfire fracture, because that is the Backfire mechanism, and then somebody had to throw a name on it, the Hutchinson fracture.

What do we see? We see a Radial Styloid fracture. Realize this is an intra-articular injury, there is going to be damage to the radial articular surface. The person is probably going to have DJD within two years because of that injury. Usually this is conservative management. We touched on this one before, but I am going to touch on it again, the ulnar styloid. This is that same Smith's fracture patient. When we are looking at these, one of the things about the ulnar styloid, if the ulnar styloid is fractured, you must be worried about the integrity of the triangular fibrocartilage, and it is complex. That is where I am going to be wanting to get an MRI on a patient that has these styloid fractures. We are looking at a coronal on this one, and this is a coronal T2. We are starting on the palm side and working our way back. There is the pisiform. You can see the thumb side over here, and as we come back, there is the triangular fibrocartilage. It is a nice dense fibrocartilaginous disk. I can already tell there is a small tear there. I can see where this person has fractured their ulna styloid. It is not attached, and there is bone marrow edema, and they have damaged the ulnar attachment of that triangular fibrocartilage. We know that the TFC is one of the major stabilizers on the ulnar side of the wrist, so this can create some pain and disability, particularly on that ulna side. When we are looking at the triangular fibrocartilaginous complex, if we are dealing with younger populations, they will dramatically tear their TFC. This being the triangular fibrocartilage here, schematically represented. In older individuals, degenerative cartilage breakdown will occur. Not surprisingly, if somebody has a positive ulnar variance, that tends to impinge the triangular fibrocartilage a little bit more.

We saw a subtle TFC tear previously. Let us look at one that is a little bit more overt. We are on a gradient echo. Now this gradient echo is panning and now we are seeing some good resolution. This person has a negative ulnar variance, and unfortunately, because of that negative ulnar variance, have developed Kienböck's disease where there is avascular necrosis to carpal lunate. But notice as we are looking at this, I can see some of the triangular fibrocartilage here, but it never makes the connection to the ulnar styloid. I am losing a large portion of it because this person has a complex TFC tear. When we look at it on the coronal T1. Notice there is part of the cartilage. Effectively, it has small attachment on the radius but it is lost most of its radial attachment. There is a large central perforation. The area going to the ulnar styloid has been damaged as well.

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What else can we injure? We start looking at the hand and wrist. This is where we start getting into a bunch of named fractures. The Scaphoid fracture, of course, in a younger population, if they FOOSH, they most commonly fracture the scaphoid. This tends to fracture in the mid portion in the waist. These are notoriously difficult to see. One of our rules is if somebody has snuffbox tenderness after a FOOSH injury, if the X-rays are normal, they are going to be put into a brace and re X-rayed in about one to two weeks. After 7 to 10 days, the fracture will show up more clearly. This one is subtle, but you can see the fracture on that oblique view.

The other thing that I do when I am worried about scaphoid fracture is, the standard wrist PA, medial oblique, and lateral. I am going to do a fourth view. I close the thumb in the fist, and then I bend to the ulnar side, and then I take a picture. What that does is help distract fracture fragments and elongate the scaphoid. Big thing on this one is do not confuse the scaphoid tuberosity with a fracture. That is not a problem. That is just where the blood vessel comes in. But with that ulnar deviation view, we can see those fractures more clearly, and the concern is what is the probability of avascular necrosis in these patients.

There is also a high frequency of non-union, which is exactly what we are seeing here. This is somebody who's developed a SNAC wrist scaphoid, non-union advanced collapse, where we are seeing that there is a nice old fracture here and it is healed non-union with two pieces to the scaphoid. But everything is progressively rotating because there is no ligament to support for that area. A more advanced case. We are seeing degenerative changes along that pseudarthrosis, and if you have a patient who is developing AVN or non-union, surgical options are going to be explored. AVN, non-union, are the two big concerns. Here is that patient that has the non-union scaphoid fracture. It is gotten nicely corticated margins. Everything is rotating, it is not where it is supposed to be, so that is the diagnostic criteria for a SNAC wrist.

What else can we break? How about a Triquetrum? The Triquetral fracture is usually an avulsion fracture on the dorsum of the Triquetrum, and it is a small little piece. This is one of those ones that has a name that I love as far as the finding goes, because when we look at the scaphoid, we know the scaphoid looks like a rubber ducky, and the Triquetral fracture is right behind the rubber ducky. That is sometimes called the Pooping Duck sign for the Triquetral fracture. You only see this on the lateral. It is a subtle finding.

Hook of the hamate. The hook of the handmade tends to fracture in racquet sports, particularly people who are maybe not great at racquet sports. What we are seeing is where the racquet is really impacting heavily into the hypothenar area. You cannot see these fractures on a standard wrist series. If I have a patient who has either hamate or pisiform tenderness, I do this view, it is the carpal tunnel view. Take the fingers, hyperextend them, shoot down the carpal tunnel, and then we can see the hook of the hamate and the pisiform are far more clearly. Can still be subtle, so we can look at advanced imaging. We can see on this MRI, there is bone marrow edema in the hamate, and there is a fracture line extending through the hook, and that is where it fractures. The hook of the hamate, the hamulus, fractures off.

When this person FOOSH, this person has dislocated their lunate. What happens? Because the extension of the wrist, it spits the lunate anterior. It is like spitting out a watermelon seed. Just spits the lunate right into the carpal tunnel, and because of that one of the symptoms that might present is automatic numbness of those first three digits as it compresses the median nerve. I know that nobody really likes the lateral views of the wrist. You can see this on the frontal view of the wrist, and there is a food sign, and that food sign is called Pie sign because as the lunate dislocates, it rotates, and it starts to look like a piece of pie.

Ligamentous injuries are the other injury that can happen to the wrist. We know that we cannot see ligaments on X-ray, but one of the things that is beneficial is we can look at relationships. One of the relationships that is really important in the wrist is the scapholunate space. All of the intercarpal spaces should be pretty uniform, but if the scaphoid ligament is injured, then we are going to see an extra gapping in this area, and that extra gapping is called the Terry Thomas sign. That tells me that the scapholunate ligament is injured, and the diagnosis is Scapholunate dissociation. This being Terry Thomas, who is known for having the gap in his front teeth.

As that occurs, we can start to see rotation of the scaphoid-lunate-capitate complex. We can see what is called the Signet ring appearance for the scaphoid. As that scapholunate association progresses, the scaphoid and lunate get further apart from each other, until eventually the capitate can drop into that space, and that is a SLAC wrist, Scapholunate Advanced Collapse. When we are looking at this, this can be cumulative stress, this can be single event traumas. The big thing is this person is losing dexterity and they are losing grip strength because you need a stable carpal row to hold a really tight fist. They are losing the ability to use their hands as effectively.

One of the other things that can happen as a late term sequela when we start looking at some of these ligamentous injuries in the wrists are things called VISI and DISI, Volar and Dorsal Intercalated Segmental Instability. We look at this on X-ray and we can see it on MR. The important thing is when we start looking at alignment in the wrist… I know that nobody likes the lateral view, but the laterals are important because we are going to look at two axes. We look at the scaphoid axis, then the lunate axis, and take the scapholunate angle. Look at the scapholunate angle, it should be between 30 and 60 degrees. If it is over 60, that is dorsal intercalated segmental instability, and if it is less than 30, that is volar instability. We can see just as a schematic representation how the lunate is going to change its position.

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In this case, when I look at this lunate, I notice that the lunate is pointing towards the backside of the wrist. It is pointing towards the dorsum. That tells me that this is dorsal intercalated segmental instability, which is usually a scapholunate ligament injury, and in this person, the lunate is tilted towards the palm side, the volar aspect, and that makes that a VISI. We are looking at carpal instability patterns, and these are patients that are generally going to be looking at hand surgeons for reconstructing the integrity of their carpals.

We get down into the hands. Breaking metacarpals and breaking fingers. We start looking at metacarpals. The first metacarpal has a tendency to fracture proximately, and if it is a simple fracture, it is a Bennett. If it is communited fracture, it is Rolando. I am unsure why they had to name these injuries differently. I am assuming two different people need a tenure and had to publish articles. A lot of times these are going to be intra articular fractures, and we are going to start to see quite a bit of DJD happen in that saddle joint of the thumb and create some difficulties.

The distal portions of the second through fourth phalanges. There is a couple of different names through here. Some people are very picky about making distinctions, some are not. But if we start seeing fractures of the distal portions of 2, 3, 4, or 5, how do those most commonly happen? You make a fist, and you punch something. Which metacarpal breaks depends on how you throw the punch. If you are throwing a straight punch, a good martial arts style punch, you are going to be hitting through the second or third metacarpals, and that is where we will see those second and third metacarpal fractures. One of the terms that is applied to this is a Boxer's fracture, because that is somebody who knows how to throw a punch. Then, you get the person who watches too many action movies and roundhouse punches. With those roundhouse punches, the fourth or the fifth metacarpals impact, and they break. Those are sometimes called Bar Room. You will see both names used. Boxer's and Bar Room. Just recognize that this is most commonly going to happen because somebody punched something, and one of our concerns when we start dealing with people punching.

This one is not so much of an incident sport because Bare Knuckle boxing is not allowed anymore. But what about hockey? Helmet comes off, throw the gloves down, start wailing on each other, like a good game of hockey. One of the things we see is the possibility of something called a fight bite, because when this person tries to punch their opponent in the mouth, it is a good chance their teeth can impact your knuckles, and if it does, and it breaks the skin, and maybe even violates the joint capsule, there is a concern for developing septic arthritis in the metacarpophalangeal joints because of that fight injury.

Gamekeeper's thumb is not really so much an athletic sport; however, skiing is. In either case, regardless of which name you want to use, this is a hyper abduction injury of the thumb, and with that abduction injury of the thumb, it creates an injury to the ulnar collateral ligament at the metacarpal phalangeal joint. We can see a couple of things here. It is altogether possible to just tear the ligament. The X-rays can look normal but that is

where maybe doing stress radiograph is important. You stress the finger over and take the picture, well thumb over. But the thing that tends to happen more commonly is this person will avulse a piece of bone. You can see the host site right through there, and that is the Gamekeepers or Skier's thumb. Concern being this does destabilize the thumb. So quite often these are going to need surgical repair.

The other concern is that there is a possibility that this fragment can displace under the palmar aspect, and it can start to scar up some of the palmar tissue there. That is called a Stener lesion. Quite often Gamekeepers lesions are going to wind up getting repaired.

A couple other named fractures, when we start dealing with finger fractures, watch the finger move. How well do the fingers move? Do they flex? Do they extend? Is there smooth motion at all the joints? Well, because one of the things that can happen with flexion or extension injuries is we can see avulsions. In this case, we are looking at a volar plate fracture coming off that middle phalanx. This person might lack the ability to have good flexion at their PIP joints because they hyperextended it and avulsed the tendons. This case, they had to use a pen to extend the person's finger, and that helped distract the fracture fragments.

The Baseball finger or Mallet finger. Mallet finger because it looks like a hammer, Baseball finger because I am about to catch a baseball and it catches me on the tip of the finger and it hyperflexes me at the DIP joint. What we are going to see is a fracture on the posterior aspect of the distal phalanx. One of the general concepts on management on these, if it involves less than 25% of the articular surface, these are generally conservative management. More than 25%, quite often they are looking at surgical management for those cases. If it is on the dorsal aspect of the DIP, that is a Baseball finger or a Mallet fracture. If on the volar aspect, that is the Jersey finger or Rugby finger. That is where you are grabbing somebody's jersey as they run and it hyperextends the tip of your finger at the DIP joint and it avulses that flexor tendon. Same rules apply. 25% or less is usually conservative, over 25% of the articular surface looks at surgery.

The last of the finger fractures all the way out at the very tip of the finger is the ungual tuft. That thin spongy bone at the end of the finger is very susceptible to crushing injuries. One of the concerns is quite often you can see nail bed injuries with these because it is a crushing injury, and this person often has just won the purple fingernail award. Now there is a slight increase in infectious rates if somebody has an ungual tuft fracture, and they have a subungual hematoma because that does qualify as an open fracture. That is something that will have to be monitored to make sure that this thing is healing and not starting to develop an inflammatory reaction.

That takes care of Upper Extremity Injuries Part 2. When we come back, we will be getting into Lower Extremity Injuries.

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