ICSC IMAGING Module 3
Section 8_ICSC03
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Video Lesson: 1:05:59

It is time to work our way down to the lower half of the body and start dealing with the lower extremity. When we did the upper extremity, we started proximal and went distal clavicle, to shoulder, to elbow, to wrist. I am going to do the lower extremity a little differently because the knee is a huge topic, and the knee is such a very large topic, I want to make sure that I devote an entire hour to it. We will cover some general topics, hip, and ankle in the first hour and then I am going to tackle just the knee in the second hour.

Let us start off with a couple of general topics because these can happen anywhere, upper, or lower extremity. There are soft tissue injuries, the first place to go is myositis ossificans. One of the facts about the term myositis ossificans is implies a tissue. Myositis ossificans says to me that this is something that happens in the muscle. Well, it does, but the problem is it also happens in not muscle, because of that, a better term than myositis ossificans is to call this heterotopic ossification, which basically we are saying their bone formation in injured tissue. We will see this, the original descriptions for this were muscular, and we would have somebody who had a deep muscular hematoma. The quads are a notorious location for this to happen. We can also see the glutes, but quads glutes, hams, and we would see a trauma happen to the muscle and a hematoma would form. Hematoma is an actual blood pool, and so there is a cystic pool of blood inside the muscle. For that cystic blood pulled to heal, it starts to heal from the outside and it heals inwards, filling in that blood pool.

In some cases we will see, instead of healing the way it should be creating muscular tissue or by extent ligament, fat, any of these other tissues that it is in, what we see is the tissues undergo a metaplastic process. It is not a neoplastic process. It is a metaplastic process. It is not a cancer, and it is just forming something that is not supposed to. We will see this start to form bone. When we see this bone formation, it forms very much like the hematoma heels. It starts more mature on the outside and then it gradually fills in. One of the problems that we run into, particularly for dealing with under 25-age range patient, is that there is something else that creates bone in the soft tissue. That is something else is an osteosarcoma.

One of the things that is on our differential list when we start dealing with myositis ossificans is, are we looking at myositis ossificans/heterotopic bone, or are we looking at an osteosarcoma? Because there is a drastic difference in management between those two things. Well, we use this thing called the zone phenomenon to help us figure that out because when we look at this heterotopic bone formation, again blood pool, hematoma, so it starts with that blood pool and the more mature bone is on the outside border, and then it heals inward. Then once it is healed, it is solid mature bone, and the solid mature bone really does not look that much like osteosarcoma. Osteosarcoma looks like immature bone, but it starts on the outside and works its way in. Whereas, when we look at an osteosarcoma, an osteosarcoma, you are starting from one cancer cell and then spreading out from there. So, we tend to see more mature bone centrally in an osteosarcoma, and then less mature bone as we move out peripherally.

This can be a difficult call when we are looking at a radiograph unless where it is something like a CT might be useful if we are not sure, is this a heterotopic bone or is this an osteosarcoma? History would also be nice too, but when we are dealing with osteosarcoma, we are dealing with the under 25 age group and really, we are dealing more in the teenage children. We know the teenage children are not always necessarily super reliable in history, and they also tend to get injured a lot if they are athletic teenagers. Otherwise, when we start to see this particularly in adults, it tends to be much more mature in appearance. We can see like in this case, there are some nice bone formation in the soft tissues right in through there. Now, this would be a true myositis ossificans because this one is in the muscular tissue. It does not just form in the muscle. It can form in any soft tissue. One of the places that this is a very common finding outside of the lower extremity is up in the shoulder in somebody who is had an AC separation and AC injury. We can see where this person has had a grade 3 acromioclavicular injury and notice all the bone that is kind of hanging down off the clavicle. Well, that is all heterotopic bone, and it quite often fills itself in along that pathway of the core called clavicular ligaments. So, really interesting phenomena there as that metaplastic process, but it is also fairly easy to identify when we know that there has been trauma. One of the other places that we will see this is and it

creates an interesting thing is in the lumbar spine in patients that had transverse process fractures. It is possible to see something called lobs lumbar ossified bridging syndrome where the hematoma that forms in the paraspinals, the QLs and the intertransversarii, can ossify and we will start to see bone bridging between the transverse processes.

The second of the soft tissue lesions, the generic heading is the Morel-Lavallée lesion. With this particular injury, it tends to be something that we see more commonly in the lower extremity, but it can happen in any soft tissue. The concept on this is, we are looking at something called internal degloving. There is a force that shears across the soft tissues, and as it shears across the soft tissues, it separates fascial planes. Quite often, this happens at the junction between subcutaneous fat muscle or inside subcutaneous fat layers. What happens is, when that shear occurs, it creates a pocket, and that pocket fills up with fluid. First as a hematoma and then eventually it becomes blander as the body breaks down the blood products.

If this lesion gets compressed early on, it goes away because the tissue is still raw. If you compress it, it will squeeze the fluid out. It will be resorbed by venous and lymphatic drainage, and then the raw tissue will heal together with some scar tissue, of course. The problem is, if it is left alone, once that fluid-filled cysts starts to form and it stays there eventually develops a fibrous capsule all the way around, and this person is kind of stuck with a water balloon inside in their subcutaneous tissues. If that is something that becomes bothersome, then it is going to have to be surgically removed. Early management on these is an important thing. One of the big clues is when you look at this patient, you will notice superficially, that there is the other can be a soft tissue mass, and it has that very fluidy consistency.

There is a really interesting paper on this but because of copyright issues, I cannot post it in the notes, but if you Google N-E-J-M, New England Journal of Medicine, lumbar, Morel-Lavallée lesion, there is an interesting paper from a chiropractic perspective where I believe the gentleman fallen down. He had sheared the tissue across his lower back and upper sacrum, and he created a Morel Lavallée lesion there. You can see it clinically, so I recommend you take a quick second to Google that paper. As we start looking at these lesions, let us go ahead and look at one of these in live action. We are looking at a knee in this case. You know how things come in in your office. They usually come you get the same thing three or four in a row. I had the same thing come in three or four times in a row knee Morel-Lavallée lesion, say that three times fast, it rhymes.

Let us look at what is usually happening here. Knee is a great location because if the knee versus a dashboard or falling down, this could be something like sliding into a baseball home plate or something like that, to create that shear. The greater trochanter is another fantastic location to see this. It can sometimes be confused with trochanteric bursitis. So, as I am looking at this one, okay, I know that when I am looking at MRI, I always start on fluid-sensitive sequences because I am looking for that angry tissue. I am always looking for something edematous. Let us start off on the coronal proton-density, fat-suppressed. I am going to start in the front because starting in the back of the knee always drives me nuts. I will start in the front, so superficial skin, and I see the patella.

I am seeing some edematous changes in the superficial tissues through there. They keep going in further, I am getting into the knee. I do not see any internal joint effusion, but I see a small area of bone marrow edema on the posterior aspect there, and then coming out the back side. Then I am going to kick over and we will talk more about knee MRI in that second hour. Now, I am going to kick over to the axial. Here, I am looking at a gradient echo, which is also a fluid-sensitive sequence. We are starting in the femur, and we are working our way down. We are starting to see the quad tendon. If you remember, we did see that there was some soft-tissue edema in the inner medial aspect. As I am looking at this on the axial, yes, there is some fat stranding in the sub-Q fat, but more importantly, there is a fluid-filled pocket here. It is not in a location where I am expecting prepatellar bursitis. It is not in a bursal location. It is separating some layers of fat here. That is what tells me that this is a Morel-Lavallée particularly, this was an auto accident and this person had knee versus dashboard. So, in this case, this one does not have a really thick heavy fibrous capsule to it. There is still a lot of Sub-Q edema. This is a more acute phase lesion and this would be a fantastic time to get this thing detected. Get it compressed. See if we can keep this from becoming a surgical case.

Morel-Lavallée lesion, it is one of my favourites It is a lesion, I had never heard of it, until about 10 years or so ago, then I saw a lot of them coming through my reading practice, and just an interesting phenomenon.

Another thing that I want to talk about is predominantly a lower extremity topic, but it is not isolated to just the lower extremity, and that is stress fractures. When we start looking at stress fractures, it is going to involve the lower extremity more because this is something that we tend to see in those lower extremity, repetitive sporting events, particularly things with running. When we look at stress fractures though, we actually break stress fractures into two categories; fatigue fractures and insufficiency fractures. Usually, we use fatigue fracture and stress fractures synonymously. To give you what is the difference between the two are a stress fracture is an abnormal stress on normal bone that then fails because it is overloaded. This is where we see a lot of repetitive stress injuries particularly, marathons, and running events, fantastic for creating stress fractures. Insufficiency fracture, the definition is actually very similar, just flopped. This is going to be normal stress on abnormal bone resulting in mechanical failure. Now, we did not talk about pathologic fractures through the course of our injuries, but does not that sound like a pathologic fracture? It is normal to stress on abnormal bone resulting in failure. Well, an insufficiency fracture is a pathologic fracture, but not all pathologic fractures are insufficiency because the idea here is normal stress.

Video placement: 13:08

This is one of our classics, grandma, grandpa's walking down the road steps off a curb and breaks a hip, or compression fractures of vertebrae. That is where we are talking about an insufficiency fracture, as opposed to grandma or grandpa fell, and they are osteoporotic, so they fracture their hip. That would be more of a traumatic pathologic fracture. Now, one of the problems that we have to deal with when we are looking at stress fractures or stress fractures on my differential, I have an athlete, that athlete has really started ramping up their activity to get ready for an event, or to try to push into the next class, and because of that overdoing it, they wind up creating mechanical stress through the bone, and the bone starts to fail.

The problem is, we will not be able to see anything on X-ray for 7-10 days, if it is an extremity; for 21 days if it is in the axial skeleton. That is something that we must be aware of, how long is that pain been there? You know, I really started ramping up my activity. I want to do a want to go from a 5K to a 10K, so I am running a lot more. It has been bothering me for about the last 5 days. What am I going to see on an X-ray? Bones, and it is going to be a fairly normal skeletal structure. That is when we have to be aware of that particular phenomenon, 7 to 10 days in extremities; 21 days in the spines/axial skeleton.

Where does that plays a role is? Pretend I am not a heavily athletic individual, but I decide to go off on a 5-mile hike. If I go off on a 5-mile hike and I am about 4 miles into the woods and I am already getting tired, and I run across a bear, I am going to be turning myself around and running the other way. I am running for miles, and I have not run that far in a lot of years. This is something, that is an abnormal stress on my relatively normal bones, and my bones might fail. If I came into your office the day after running that much with all this pain, what are we going to see radiographically? Nothing.

Now, what do I do for a living? I, either A, talk to my computer teaching webinars or B, I stand in front of a class of chiropractic students teaching them. So, I walk around a little bit, but could I do my job sitting? Sure. In this scenario, we would call that a weekend warrior athlete.

Let us do some conservative management. If we need to, we will re-X-ray in a week. What if we are dealing with a division 1 athlete? Somebody whose scholarship rides on their athletic performance or a professional athlete whose pay check is dependent upon them performing? That is somebody where we are probably going to go above and beyond and really try to make a diagnosis. That is where we have a couple of options. We can look at bone scan, or MRI. A bone scan is not going to be my first option for this. I would much rather get the MRI. It is going to let me know if there is a stress fracture, or whether it is not a stress fracture, but there is a soft tissue injury. I would rather go that direction. Something else that is an important consideration if you are dealing with pediatric athletes. One of the other things to consider in the lower extremity is they can have a very similar presentation. A gradual insidious onset of pain in the lower extremity bone. Osteoid osteoma can have the same presentation. So, that is one of those things that makes it worth imaging to see whether it is consistent with a fatigue fracture? Is this an osteoid osteoma? Do we need to take it to the next level? Some of the common locations where we will see these different kinds of stress fractures, we already talked about the lumbar spine and the pars hyper extension sport creates, we are seeing the stress fracture that heals non-

union. But notice when we look at this entire list, lower extremity, lower extremity, lower extremity. Most of these lower extremity because that is where there is repetitive sports come into play.

Is it possible to see the upper extremities? Coracoid can stress fracture in somebody who is doing repetitive shot gunning so trap shooters, skeet shooter things like that. The hook of the hamate look, we have talked about previously in racket sports. One of the problems with stress fractures, if we leave a stress fracture alone and particularly, we have a heavier duty athlete, who is going to push through the pain and keep doing their event, that stress fracture can eventually become a complete fracture. That is where that gets to be a problem. So, what do we see? If we are in, okay, it has been bothering him for two weeks and now they are finally come in and to see you. What am I going to see? Generally, I will see a faint white line running perpendicular to the long axis of bone, or perpendicular to the axis of force when we see a calcaneus, okay? We might see some periosteum lifting. It compares, we might see some periosteum lifting like we see this is a young ballerina. Periosteum lifting, nice white zone coming across the tibia and realize shin splints are a prestress fracture.

When we start talking about shin splints, shin splints if you keep doing that activity, it eventually becomes a stress fracture. That is where we can start looking at, when do we need to start imaging these? Another great candidate of people forgetting physique rashers, stress fractures, and military recruits. Let us take the average 18-year-old who is been spending a lot of time on Xbox and joined the military. All of a sudden, they are marching and running where they were not expecting to. What do we see? We can see where there is this white line running perpendicular to the long axis of the trabeculae. Remember, when we are dealing with that acute phase, so attendees in extremities, what am I going to see radiographically? Normal bones. Do not forget too, when you have got somebody who is got focal pinpoint tenderness it hurts right here, and that leg is a long, that is a long study. Put something on the X-ray that says, "look, here, this is where the problem is." Maybe that will help us Identify some more subtle lesions.

Now, in this case, this was followed up with a bone scan. On the bone scan, we can see that at that area of maximum tenderness, there is some increased uptake. So, we do not see on the X-ray; the X-ray is normal. But on the bone scan, we do see that radiopharmaceutical increase for a stress fracture. I introduced this patient to you before. This was the patient who had decided to do a marathon and increase their activity started having sacroiliac pain. X-rays were normal. They got a CT instead of getting an MRI. On the CT, we can see the little sclerotic focus because the thing is with marathoners there kind of notorious for getting a vertical sacral stress fracture. We can see on the MR there is the halo of bone marrow edema on the T-2 that confirms that is a stress fracture.

Watching a couple of live demo DICOMs here. I am starting off with a navicular, and we will be talking about the Ottawa foot and ankle rules here in a little bit. This would be somebody where we would be considering running some imaging. We have a patient who has increase their activity. With that increased activity, they started experiencing quite a bit of foot pain. We are looking at a foot MRI, and I start off on a fluid sensitive. This is a proton-density fat-suppressed. We are in the ankle. You can see there is tibialis anterior. There is Tom Dick and Harry. There is the Peroneal. As we come down through the ankle mortise, getting down into the foot, all of a sudden, the navicular is lighting up. We are seeing substantial bone marrow edema. The X-rays are normal in this case, but we can see that bone marrow edema with normal X-rays. This is a navicular stress fracture.

This next case, again, I am unfamiliar with the history aside from knowing that this was an athletic individual. The person was having hip pain that was getting progressively worse. They were still doing their activity. It is getting progressively worse. Bone density was adequate, and as we look at the fluid-sensitive sequence, again, we are looking at a coronal stir. What do we see? There is a zone of impaction here on the medial side of the femoral neck and it is surrounded by marrow edema. All of that is very consistent with a stress fracture. Okay. Now, from there we are going to get into the pelvis. Now, as we start looking at the pelvis, realize, when you think back to all the pelvic fractures that you learned in chiropractic school, there was a bunch of things that we learned. I know because I still teach them, but to generally not ambulatory chiropractic patients. If this is something that we are going to happen, if you are a field side doc, this person is going to be in a world of hurt.

This is not somebody where it is going to be coming in and we are going to take an X-ray and find out they have got a malgaigne or a bucket handle, but just to kind of review some of these fractures. So, the malgaigne injury, we are seeing where the person goes through the SI joint, the iliac or the ilium, and then through the same sided superior and inferior pubic rami. The bucket handle goes through the opposite side. Again, we are not going to see these in the acute phase. Again, even if we are sports field side, if somebody were to have this kind of injury, A, I would wondering how they got it, but B, okay, this person is going to be getting transported because they are going to be dealing with some blood loss. The straddle fracture goes through the superior, and inferior pubic rami. The unilateral straddle fracture just goes through one side. The duverney fracture takes off the illiac wing. Pubic diastasis would be abnormal; widening of the pubic symphysis. Then a sprung pelvis would be diastasis plus diastasis of an SI.

Video placement 23:46

I just wanted to cover those just to refresh your name, or refresh your memory on the names, but again, we are not likely to see those. What we are going to see though, hopefully, I will give you a second to look at this X-ray and see if you can identify what pathology is going on with our patient here.

Answer: Hopefully you said, ankylosing spondylitis.

Our patient is working on bilateral sacroiliitis. It is getting closer to the point of SI joint fusion. Just want to throw something else up is a little bit of an eye test. Now, what else can we break in the pelvis? Something that maybe is a little bit more realistic, acetabular fracture. With acetabular fractures, again, motor vehicle accidents are very common for these, but we can also see them in any event. The knee hits something and drives the femur backwards because again, convex femoral head into the concave acetabulum, the acetabulum tends to fail.

There are two major acetabular fractures, the dashboard, which we are more likely to see. The blowout, I am not even going to really cover aside from just the name. The dashboard fracture is a knee versus dashboard or knee versus a mobile object. It drives the femur back and it runs into the acetabulum and breaks the posterior acetabular wall. The blowout fracture is a side-impact style injury. Something hits the greater trochanter and drives it medial and it blows up the pelvis. It is a very unstable pelvic fracture. The dashboard fracture though, this is something that can be ambulatory. That can be coming in a couple of days or a couple of weeks later. Now, with the persistence of hip pain. What we see when we are looking at this person's radiograph is there is a subtle line running through the posterior acetabular border here. We know that the pelvis is a very complicated piece of anatomy. So, anytime, is that real? Am I making things up? I am not sure. Get a CT.

CT is going to give us that bony definition and here, I can see where this person does have that posterior acetabular border fracture. Very consistent with a dashboard injury. I am also going to be worried about the acetabular labrum in this patient. Any time we see acetabular injuries, the labrum is one of our considerations. Now, other things that can happen as far as pelvic injuries, particularly in getting back to that dealing with pediatric sports up through 16-18 years of age. We can also start to see some avulsion in the pelvis. I like to use ankylosing spondylitis patient here, just as an example. There are three possible avulsion sites. Well, there is a bunch, but there are three big ones. The ASIS, the AIIS and the ischial tuberosity. Those are the big three places where we are going to see avulsion injuries happen. These avulsions happen in one of two ways, either A, single event. There is one event, pushing person, really pushes and it avulses the bone.

Possibility two, and this one's a little bit more likely, is chronic repetitive stress. Pull a little bit. Pull a little bit, and then eventually they avulses. When we start looking at these, so the big three, ASIS, AIIS, and initial tuberosity, so, with the ASIS, now, this is one. When we see those fractures occur, they tend to move inferior because the muscle is pulling the piece down. We can see whether this ASIS is displaced inferior, but it is also healed at this point. Go figure, this person might have a change in mechanics with the change in orientation of the sartorius, and they would have a palpable difference in their ASISs.

Pediatric patients, we can see the displacement of the AIIS, and one of the questions that comes on these is, does this need to be surgically repaired? It depends on how much distraction there is. This is a late sequela for the ischial tuberosity. Ischial tuberosity avulsion is due to the hamstrings, and not surprisingly, this is

something that we can see in equestrian sports. One of the things that happens with those hamstring avulsions, again, is chronic repetitive stress where it avulses a little, avulses a little. Well, it can elongate over time, and what we are seeing here is we see a normal ischial tuberosity on this side. We can see the overgrowth of the ischial tuberosity on this side. That is something called a rider's bone. Not surprisingly called a rider's bone because it is seen in equestrians.

Our next injury up is an interesting one. It goes by a couple of different names. Probably, the more appropriate name is athletic pubalgia. It has been called a sports hernia in the past. Really sports hernia is a term I would probably try to avoid because when we think hernia, we think something poking through something else. There is not really a true herniation in these cases. What we are seeing is we are seeing muscular injury. It is typically in somebody who does a rotation of the torso. They do a rapid deterioration. So, baseball pitchers, American football, quarterbacks, hockey goalies. Really, any hockey players, because when you start looking at slapshots can do this. The big thing that is kind of a close. We have the person that does this twisting event and all of a sudden, they start dropping in performance. They cannot hit the puck as fast as they used to. They cannot hit the 90-mile an hour fastball anymore. It is dropped. They have dropped 10 miles an hour off their fastball.

They are starting to get some pain in the groin. What is happened is they have damaged where some of the small muscles are inserting into the pubic rami. They have damaged the rectus abdominis insertion, the origins of the pectineus, the gemeli and some of adductors, and it takes away a lot of that rotational force. So, when you have that pain in that area, it is down towards the pubic regions and you are starting to lose a lot of your strength. Let us get an MRI to see what is going on. Keep in mind, that this could be an inguinal hernia. It mimics an inguinal hernia, which is where it got its name sports hernia, but they do not actually have a hernia. There is nothing of those. There is no small intestine poking its way through or anything. So, they get checked for a hernia. They do not have a hernia

Then we need to consider that this is actually a muscular tendinitis issue. So, we need to go for an MRI for a case like this. What we are going to see is we evaluate an MRI for this patient. We are going to get a pelvis MRI because that will show us all the pubic region, and there is a possibility of seeing some increased signal in the pubic rami, but much more likely, notice that there is this edematous change in the muscular tissue here immediately adjacent to the superior ramus. Pectineus, gemeli, adductors, rec fem. Rectus femoris reports will be a little bit higher up more in through this area. But we will be looking to see, is there any signal like we are demonstrating here in this case in pectineus? This person is going to end up having to rest and then rehab back with those rotating muscles. One of the other things this brings us to, so as we are working our way down through the pelvis, something else that can create pain in the hip or anything or a region is the acetabular labrum. Now, it would be the whole job of the acetabular labrum is very similar to the glenoid labrum in that it deepens the socket, creates additional stability, and helps guide motion. Now, we can see a couple of different things that will involve the labrum. The first possibility is labral tears. If you get somebody who is in an impinged position flexion and abduction, adduction, internal-external rotation, they can impinge on that anterior acetabular labrum and create labral pathology.

One of the other things that we can see is, okay, does this person just tear their labrum, okay, or do they have femoroacetabular impingement syndrome. Not surprisingly, we start with X-rays and we are trying to figure out why somebody has hip/groin pain to see if there is something going on. Now, I am going to go through the labral path and then we will see the X-ray stuff. So, if I am worried about the acetabular labrum, okay, hockey goalies, are big candidates for this because of all the time spent crouching. Drop it on the ice and move their knees to block pucks, but anybody who is doing a lot of repetitive hip activity like that. If I am worried about the labrum, I know that I am going to go to an arthrogram. That is something where there are, no if's, no second guessing, no but's, I am going to get a hip arthrogram because it is going to be up to 60% more sensitive for labral pathology. That is the first thing; I am going to make sure I get the arthrogram.

Video Presentation Placement: 33:07

What would make me suspicious aside from the history? Things that I might see on the radiographs. Some of the things that we will see in radiographically in patients with hip pain, something that for the longest time was just considered an incidental, the finding is Os acetabulum. This is an accessory ossicle that occurs around

the acetabular margin. It was okay. You got a nice acetabulum. Yeah, you, got an extra bone. Instead of 206, you got 207. Well, one of the things that have been shown and realised femoral acetabular impingement syndrome is a newer diagnosis. Newer being in the last 20 years. This had shown that you look at epidemiology, patients with an Os acetabulum have an increased incidence of femoroacetabular impingement syndrome. Make sure that it is not a fracture. It is got smooth all-around a coordinated margin. So, that really lets me know I am not looking at something broken. They can be a little bit harder to discern. This one's on a more posterior aspect of the hip so it is hiding a little bit. Maybe can even look like an osteochondral fracture, and I would end up having to get some advanced imaging to evaluate that. What that does do is it brings us to femoroacetabular impingement syndrome, FAI. Now, again, newer diagnosis, this is a last 20 years kind of diagnosis. What was been noticed is that the acetabulum or the femoral head/neck can sometimes have variability in appearance. That variability in appearance actually predisposes to damaging the labrum.

There are two kinds of femoroacetabular impingement morphology. Just because you have the shape does not mean you have the FAI, but predisposes. So, the first type is the camp type. What makes the camshaft? Well, it is got an oblong surface to it. That moves the valves in your engine. See? The other kind is the pincer type, a nice crab claws. A good explanation of a pincer. Now, what are we talking about? and now I know what a camshaft looks like and that blue crab claw and when we look at the cam time as we are looking at the AP view, notice that there is a small lump on the lateral aspect of the head/neck junction, and sometimes it might be more on the head. That is the cam type. The problem is that this person is going into flexion and abduction. That little ridge is going to run into the acetabular labrum that lives right here and damage the labrum.

The pincer type is usually an overgrowth of the acetabulum. This can also be something that is acquired as somebody develops DJD of the hip joint. The osteopathic growth can create a problem on Os acetabulum, and can deepen that acetabulum. You can imagine as this person's going into flexion abduction, that is going to impinge on their femoral neck, and that impingement will potentially damage the labrum. These are patients that have a find camera pincer type, we can always try conservative means, but if I am considering surgery because the pain is not going away or not responding, I will get that MR arthrogram to better evaluates the labrum.

Video Presentation Placement: 36:19

Something else that we as radiologists all of a sudden said was an incidental finding, what they do, pitts, synovial herniation pits. It is really common in the femoral necks to find these little circular loose bits. We always say, "Yes you got pitts pits." Well, after femoroacetabular impingement syndrome was discovered and people started putting together a couple of different things and discovered, "Oh, we see pit synovial herniation pits much more commonly in patients with femoroacetabular impingement. That is another one of those little subtle clues that if my patients got hip pain, I want to make sure I am checking out that hip very carefully. Then we are coming out of the acetabulum. We are coming into the proximal femur.

Realistically, when we are dealing with most athletic events, hip fractures are not terribly common. Now, as to risk, as we are seeing more extreme sports, we are seeing more significant bone fractures. Femur is the strongest bone in the body. The tibia is the second strongest bone in the body. Well, if you are doing extreme sports, it is more likely to fracture. Typically, when we start thinking about things like hip fractures, usually we are thinking about grandma and grandpa. Yeah, we are thinking about our older patients or elderly patients. That is who typically is going to fracture their hip because it takes a lot of force. In young people, mostly we are dealing really severe forces, big falls from big heights creating these problems. Fatigue fractures are a possibility stress fractures, but generally, we are thinking about the older individual.

Just as a reminder of some of the different locations, when we start talking about these proximal femoral fractures, one of the things we do is divide the fractures which from intracapsular versus extracapsular. This is more for the orthopedist than it is for the conservative care clinician because if there is a fracture in these locations, it helps the surgeon decide on total hip replacement or dynamic hip compression screw. So, the location sub-capital, mid-cervical, basicervical, those are inside the joint capsule. Trochanteric, intertrochanteric, sub trochanteric. As we look at those fractures, there is all of them because it is a nice pretty colourful thing, the one that makes me nervous. Elderly patients, we will see the other hip fractures, the one that makes me really nervous is the lesser trochanter. If the lesser trochanter comes off, that is a huge red flag

for pathologic fracture. Whether osteoporosis or metastatic disease or something, malignant, the lesser trochanteric fracture is not a common thing and is not generally good news for the patient.

What are we worried about when we start looking at those fractures? The reason that these tend to be operatively managed is because of avascular necrosis and non-union. Notice, I have not really talked about like midshaft fractures on femurs. I mean, those are straightforward. That is going to orthopedist and they are going to put an intervention and they are nail in. I am not going to worry too much about diagnosing some of those fractures. All that being said, the hip fracture that I do worry about seeing, and this being much more likely is SCFE, slipped capital femoral epiphysis. What we are seeing here is we are dealing with an adolescent patient, and typically, this is an overweight male and they start complaining about knee pain.

As they are complaining about knee pain, they are starting to develop a limp. They usually have a bilateral or they start to develop a trendelenburg gait where they are getting that hip thrust. But what is interesting is they usually complain about knee pain. Well, we start evaluating the knee and we cannot recreate the pain. Time to check out the hip and that lights the patient up. There are a lot of things like pediatric hips, Legg-Calve-Perthes, avascular necrosis. SCFE, slipped capital femoral epiphysis, this is a type 1 Salter-Harris fracture. Septic arthritis is kind of notorious in pediatric hips. I tend to be pretty liberal about X-raying pediatric hips. This is a pretty common disorder. It is the most common hip disorder in adolescence. One of those little factoids that always shows up on board exams. Children are going to have a limited range of motion and have pain when you start evaluating the hip. The big thing is, what we are looking at here, what is an SCFE? It is a type 1 Salter-Harris fracture. The general thought on this is because we are dealing with an overweight child this is almost kind of like a stress injury. Quite often, it is going to be tied in with the pubescent growth spurt when they are growing really quick and the growth plate gets a little weaker. We can see it is predisposed to other conditions. If there are underlying metabolic bone diseases, those children are more likely to get these, but realistically, it is the overweight that is hitting the overweight child, that is hitting their growth spurt. So, what do we see? Really important to us, that when we start looking for pediatric hips and really all hips, make sure we are doing the right X-rays. The number of times that I see somebody default to an AP pelvis on a patient with hip problems, drives me a little nuts. So, you can do a pelvis factual out, but make sure you also get dedicated hip radiographs.

Dedicated hip films include an AP with 15 degrees of internal rotation to take out the inner version. Then the single most important view is the frog-leg because that is where most pathologies really going to show up. What do we see when we are looking at an SCFE case? What am I going to see when I start looking for SCFE? The femoral head starts to get shorter, and so femoral shaft, femoral neck, and femoral epiphysis. That femoral epiphysis rotates in two directions, either posterior or posterior medial. As it does that, if it goes straight posterior, it gets the epiphysis to look shorter. If it goes posterior medial, that is where we start looking at one of those lines. Remember, all those lines that you had to memorize at some point in time, and there is Klein's line along the lateral aspect of the femoral neck, and it should intersect a decent portion of the femoral head? If it does not, that is one of your big indicators that you are looking at an SCFE.

Video Presentation Placement: 42:47

The big deal is the frog-leg is the more important view because, on the frog-leg, we are going to see that posterior rotation that is very consistent with an SCFE. This child can be taken off weight-bearing because the more they wait-bear, the more the slip is going to occur. The greater the probability of negative consequences, such as avascular necrosis, and severe DJD. These are the kind of children that if you get a child that is got a Legg-Calve-Perthes or SCFE, sometimes these children as well as they become adults, they might be getting hip replacements in their 30s because there is so much degenerative change going on and they are having such difficulty with quality of life. This is what is typically going to be done for SCFE cases is they are going to drive screws through the femoral neck and into the head. The idea being they want to lock this in place. They are not going to try to reduce it because it is difficult to reduce to get it back in a normal position, then screw it into place. So, they leave it slipped and screw where it is, and that is why off weight-bearing, and they are in surgery pretty quick on this. The history of doing SCFE surgery is kind of interesting. Originally, the first surgery they tried to do; they drove one central screw through the femoral neck into the head. One of the things I noticed was that the femoral head could unscrew itself and can create more problems. So, then they started

to use three screws, and then, they cause avascular necrosis because they were replacing so much bone marrow. Bone marrow, space on the head. So now, they will usually use either one eccentrically placed screw or two screws and that locks things in place. What is the downside of SCFE? The big, the long and the short are DJD. These patients are set up for premature DJD. Hip replacements in their 30s or 40s are not uncommon in children that have SCFE or Legg-Calve-Perthes, or any of these pediatric hip disorders.

Video Placement Presentation: 44:51

We are going to jump from the hip. We are going to completely skip the knee and we are going to go down into the leg and foot. The second hour is going to cover the knee injuries. Just the list of the things we are going to talk about so that you can see what is coming up. Now, one of the things that is a huge, massive topic when we start dealing with sports injuries is who do we X-ray?

It would be nice to X-ray every part that has a problem, but I know that that is not evidence-based. I know that that is not safe because there is no such thing as safe radiation. There is a problem with too many negative studies that make radiologists miss things. So, some smart people out of Ottawa, particularly a doctor who ran the group, named Dr Ian Steel, started looking at emergency department admissions and they started comparing a whole bunch of physical exam findings with radiographic findings to see what correlates. In doing so, they created something called the Ottawa criteria. There is a foot and ankle. There are also other criteria for the knee. The nice thing is, by looking at Ottawa criteria, if we have a patient who does not meet Ottawa rules if this person has a less than 2.5% chance of having a significant fracture.

We do tend to be cautious and little children, and this is only for acute injuries. It is a very useful tool to help us decide who we imagine. The Ottawa rules are, OR rules, If you look at this from a Boolean logic standpoint. If A or B or C or D or E is positive, then you take a picture. If none of those things is positive, the patient has a less than 2.5% percent chance of having a significant fracture. So, what do we look at, okay? The first part is palpatory. Holcomb, and what you are going to do is you are going to palpate along the posterior Ridge, distal 6 cm of the tibia and the fibula. You are going to go distal 6 centimetres all the way down to the tips. this is one where when I am teaching to an American audience, I usually have to explain to them what 6 cm is? Has a ballpark, it is not 100% accurate because it depends on hand size, but the width of your hand is about 6 centimetres.

Next, I am palpating a distal 6, posterior aspect tip, fib down to the tips. Next squeeze, the fifth metatarsal base, that is the thing that is this most likely to be positive because the fifth metatarsal base fracture is the most common fracture in inversion injuries. Then I squeeze the navicular. We already saw that navicular stress fracture earlier. what else do we do? We do the walking rule, and in the walking role, can the person walk four steps? four steps are 1,2,3,4, and it is regardless of limping. So, good foot, bad foot, good foot, bad foot. If they are willing to touch the floor and put any weight on it, that is not positive. They have to be unwilling to touch the floor and it is both at the time of trauma and at the time of evaluation. realize, If you are on the field, that is really the same time, but if this is somebody who injured themselves on the weekend and was able to walk in on Monday, that is another story.

what kind of things creates pain and problems down in the lower extremity? this first thing is not actually a fracture. This first thing is a confounder, the Os trigonum. Now, this is an accessory ossicle in the ankle and it is named in a way that makes sense at the junction of three parts; the tibia, the talus, and calcaneus. This extra little piece of bone can be a problem in a couple of categories. Ballet dancers are kind of notorious for being a problem for ballet dancers. Sometimes with sprinters, and then because well, my wife is 4' 11'', short people. what do ballet dancers, sprinters and short people have in common? They have to stand on their toes a lot. So, with that repetitive plantar flexion, as they go into plantar flexion, the calcaneus comes up and traps that ossicle against the tibia. Over time that can create a stress reaction. We can see stress fracture of that area, and that is where that becomes Os trigonum syndrome.

try to get a ballet dancer to quit doing dance. Try to get a sprinter to quit doing sprints. Try to get a short person to grow a little bit. So, these are generally going to be an asymptomatic issues, and if they become symptomatic, quite often you are looking at prophylactic removal of that ossicle. We can look at the MR to see if there is a stress reaction. In this case, there is some edema surrounding that ossicle. this next thing is not

actually an X-ray diagnosis. There is a clinical diagnosis of Sever's disease, calcaneal apophysitis. Very common in athletic little children. Heavy heel strike and it creates inflammation in the calcaneus. normally, when we start talking about apophysitis, if an apophysis is sclerotic or flat fragmented, that means they have apophysitis.

The problem is that calcaneal apophysitis is always sclerotic and usually fragmented. So, we do not diagnose Sever's disease radiographically. It is a purely clinical diagnosis. Squeeze the calf, the child goes out, they got severs disease. We do not use the X-ray. Anybody that looks at an X-ray and says, "You got Sever's," does not know how to read an X-ray. Other injuries that can happen around the foot, mangle the Achilles tendon. We have to look at the foot there. The Achilles tendon is something that is very involved in running. So, runners are very notorious. Fifteen to 20 % percent of runners can have Achilles tendinosis at any one time. The problem is with tendinosis, if you keep using a tendon with tendinosis and overdoing it, eventually it can become a tendon rupture. That is what we are going to look at in this case.

On X-ray, there are findings where you lose the normal Achilles fat stripe. I am not sure that I would really want to rely on losing the Achilles fat stripe to indicate that somebody has an Achilles tendon there. I think I would much rather look at an imaging tool and of course, one of those useful imaging tools. Ultrasound would be good for this. We can also do this on MR, and as we are looking at the sagittal, so we are starting on the lateral side, there is the fibula coming into the talus and calcaneus, and nowhere do we ever see an Achilles tendon. This is a person who is had an Achilles tendon rupture and they have had a proximately 8 centimeters, maybe 10 centimeters of proximal retraction, which is something that the surgeons going to want to look at to help decide. Is this a conservative walking boot case or is this surgical repair?

What is going to be making me check out somebody's ankle more than anything else? Inversion ankle injuries. The most common ankle injury is an inversion injury. Well, and everybody always, "I twisted my ankle. I need X-rays." No, because what you most likely did was damaged your ATFL, your anterior talofibular ligament. Maybe your calk fit, calcaneofibular ligament really remotely, post your tailor fit. Likelihood of fracture, unless you have got positive auto criteria, 2.5% or less. That being said, we get paid people that have ligamentous injuries. Do we need to MR most of these, NO, most of these are conservative rehabilitation? We all we really work on proprioception. We work on strengthening up everything in the area and generally those patients are going to do just fine. One of the things that we know is this somebody is a high-grade athlete. Is it somebody who has to consider a surgical alternative then we can start looking at getting MRs on these patients.

Video Presentation Placement: 53:16

Could ultrasound be done? Absolutely, diagnostic ultrasound can be utilized for this, if you have got somebody in your area who is good at what they do. Absolutely, it is something you should be considering. As we are looking at these. So, the two big ligaments that were most worried about. The two ligaments are most likely damaged, anterior talofibular, calcaneofibular. To see the ATFL the anterior talofibular ligament, we look at the axial and we remember that the ATFL. The ATFL, goes from the anterior talofibular ligament goes from the talus to the fibula. Where do we look for this? Is the ATFL, notice there is a junction where the head or the neck comes up flares into the talar dome right there. That is where we are going to see the insertion of the ATFL. The origin of the ATFL is up on the fibula. Well, in this case, there is no ATFL, and this is somebody who is a higher grade high school athlete soccer football, who had multiple ankle injuries and was starting to have a lot of problems were having difficulty playing even with tape because they just kept injuring their ankles all the time. Their ATFL was injured and then we start looking for the calcaneofibular ligament in which, again, not surprising, it goes from the calcaneus to the fibula. As I look at the tip of the FIB, there is some ghostly fibers there, but there is no calcaneofibular ligament. That absence of a calcaneofibular, not surprising this person has an unstable ankle, their PTFL, posterior talofibular ligament is still beautifully intact. It is a very dense ligament. It is not injured nearly as often so PTFL looks good in this patient.

Video Placement Presentation: 55:23

What other injuries might we be seeing when we start looking at the lower extremity? The next is the Lisfranc. This one is a game changer. If we get a patient who is got a Lisfranc injury, this person the likelihood of return to sport is really remote because this completely destabilizes the foot.

The LisFranc ligament lives between the first cuneiform and the base of the second metatarsal. It lives right there. There is multiple bands to this ligament, but one of the things to keep in mind, that lisfranc ligament is almost like a keystone. It really controls longitudinal arch. It really controls transverse arch, and what it really does, it holds the tarsometatarsal joined together. That tarsometatarsal joints junction there is called the Lisfranc joint complex. Well, what we see is when somebody is gets into a forced plantar flexion, and quite often, this is somebody as part of an inversion injury. If they landed on top of their foot, and then roll their foot that way, that forced plantar flexion tears the lisfranc ligament. In doing so, it will destabilize the tarsometatarsal joint and you can see what we see here. This person has laterally dislocated all 5 metatarsals, to be honest with you. What will happen a lot of times, the first metatarsal will stay in place and then two through five will displace laterally. Generally, when we are looking at a lisfranc injury, if there is any degree of displacement, this person is probably going to be getting surgery and quite often multiple surgeries in order to repair that region.

Video Placement Presentation: 57:02

From there, let us talk about a few more fractures. This next one, the toddler fracture. Most toddlers are athletes, but you start getting little children. If you are dealing with a pediatric practice, the toddler fracture is generally a small fracture in the tibia, and usually they are very subtle and difficult to see. Little child who is starting to walk. Something that is not subtle, and that is very easy to see is the boot top fracture. Not surprisingly, we see this in skiers, and particularly in skiers whose bindings, do not let go. If the bindings are too tight and the skier ends up ditching it and the legs rotate because of the giant sticks attached to their feet, quite often, we are going to see where this will fracture right through the tib and fib, somewhere near the top of that ski boot.

How about the malleoli? When we start looking at positive Ottawa criteria, this is somebody who is going to have tenderness in the malleoli. In the malleolar fractures are very easily straightforward. This person has a medial malleolus fracture. This person has a bimalleolar fracture. They would have broken both medial and the lateral malleolus. Now thing to keep in mind. When we look at the ring of the ankle mortise, we are back to that pretzel principle, that life saver concept. A disruption one place in a ring is stable. A disruption two or more places is unstable. So, the patient like this first patient over on the left side, this person has a stable ankle fracture. They have just fractured off the medial malleolus. They are probably going to be stable according to what is called the Weber classification. This person with a bimalleolar fracture is going to be unstable.

The other thing that we can see is and one that you must remember is, there is a third malleolus. Well, it limits other medial and lateral and easy because we palpate those and see them, but realize that this is the third malleolus, and it limits us in plantar flexion. So, if an injury involves heavy plantarflexion, it is possible to fracture that posterior malleolus which is exactly what we are seeing through there. This can happen as a combination platter with the medial and lateral and that creates something called the trimalleolar fracture. One thing to realize, if you start, looking at ankle trauma, text, you will notice, man, there is a lot of names. There is duputryen. There is potts, there is a too low, nobody uses those. The problem that we have run into is the definitions of all these different named ankle fractures. They have all crossed over so much and there is so many subtle differences. We do not use those anymore. We just described what we see and stop trying to name things after old orthopedist.

Video Presentation Placement: 59:58

That is a very common injury, is an osteochondral fracture in the elbow. Well, hopeful see osteochondral fractures, in the knee, a little bit. We also see osteochondral fractures in the elbow, and where we saw the capitulate, and then the talar dome is another major site for these injuries. particularly if I get somebody who has an inversion ankle sprain. So, the foot is moving that way. They damage the lateral ligament complex. It is going to allow the tailless to run into the tibia, and then we can see some shearing off the articular surface, so then it can happen on the medial or the lateral side. This is one where when we find these osteochondral fractures, the big question is surgical or non-surgical, and these patients are usually going to wind up with an MRI arthrogram to help decide if the fragment is stable or not.

What else can we break it? Let us break a calcaneus. Well, calcaneus happens to be the most common tarsal fracture. What we see is a comminuted impaction style fracture. Sometimes the fracture itself is hard to see and that is why, not surprisingly, there is another set of lines and that is what creates something called Bohler's angle. With Bohler's angle, when Bohler's angle starts to flatten out, that is an indirect indicator that a person has a calcaneal compression fracture. Those calcaneal compression fractures are often called Don Juan fractures. One of the concerns is, they can be bilateral. They also have an increased incidence of thoracolumbar spine fracture because the person is falling from a height and landing on their feet.

Second most common tarsal to fracture is the talus. We already saw the osteochondral fracture. Other fractures that we can see when we start looking at the talus, this is an equestrian. This is somebody who is a western-style rider, and they were thrown for their horse. Their foot stayed in the stirrup and the horse took off. In doing so, it is hard to tell exactly we can see the foot is not where it is supposed to be, but what this person had is called an aviators fracture. It is a fracture through the neck of the talus. Then she had dislocated her subtalar joint. This is a post-reduction film on this particular case. The concern where we find these aviators fractures is an interrupt to the blood supply to the talar dome, and there is a very high incidence of avascular necrosis, which unfortunately ended up happening in this patient. She developed a vascular necrosis and was having a lot of sequelae as the articular surface started to collapse.

With the orthopedic and radiology circles, if you start getting those folks going, they will start to talk about the differences between Jones fractures and dancer's fractures. There are different fractures and they are not the same, but what most of the world uses is they use the two terms anonymously. What we are talking about is we are talking about a fracture of the base of the fifth metatarsal. Dancers are more distal; Jones is more proximal. We lump them together. These can be an avulsion by the peroneus brevis. They can be an impaction fracture, and one of the things we see, this is one that basketball is kind of notorious for this one, going up for a jump shot and landing on somebody's foot rolling the ankle and fracturing the foot. Unfortunately, with these fractures, there is a frequent incident of non-union. So, one of the things that must be considered is, is this athlete’s high grade enough where we actually want to screw that fragment in and be able to get this person to return to play.

The other thing that is on our differential is, in little children, there is a growth plate right there at the 5th metatarsal base. The thing to remember is the fractures - let me use a different color - the fractures are going to run perpendicular to the long axis of the bone. The growth plates are going to run parallel to the long axis of the bone. When we start looking at that 5th metatarsal. If you are dealing with a pediatric patient, trying to figure out is it a Jones or dancers fracture or is it a normal apophysis? Look at the direction. If it lines up with the metatarsal, well, then you are looking at a growth plate.

The last diagnosis for our upper extremity one class is going to be sesamoid fractures. What type of person gets a sesamoid fractures? Anybody who is on their toes on a hard surface. Basketball is notorious for this type of fracture. Hard court, bad shoes also contribute, runners, sprinters are on the balls of their feet a lot. When I get somebody's doing that kind of repetitive plantarflexion activity and they start getting pain under the 1st metatarsal head, that is pretty classic for a sesamoid fracture, sesamoid fatigue fracture, sesamoid avascular necrosis, they are lumped together. Definitely we are taking some pictures, and what do we see? We can see here there is some fragmentation of that lateral hallux sesamoid.

The question is, is that a fracture or is that a bipartite sesamoid? Remember the mantra? Smooth, well-rounded coordinated margins. If something has smooth well-rounded coordinated margins, it has been there for a long time. If it is sharp and jagged, like we see, in this case, that is an indicator of an acute fracture. There is also a special sesamoid view. It is very much like doing the sunrise view in the knee. You can have the person do a runner stands on the X-ray cassette and you will shoot down through the sesamoid at the metatarsal head. Notice the sclerosis in this case? Is that avascular necrosis? Is that a healing fracture? It is a difficult call, but we are seeing that sesamoid injury in these patients.

That takes care of lower extremity injuries. We will come back in our last module and we will talk about everything that can happen to the knee.

[END]