ICSC IMAGING Module 3
Section 5_ICSC03
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ICSC03 – Section 5 Spinal Injuries Part 2

Welcome to Sports Imaging of the Spine Volume 2. We are looking at the second hour here getting into the thoracolumbar and sacral injuries. As we start dealing with these, of course, we left off talking about disc herniation in the thoracolumbar spine. Let us actually start talking about some of those thoracolumbar spine injuries.

Not surprisingly, the most common type of spinal fracture is going to be the compression fracture in the thoracolumbar junction. Thoracolumbar junction being mechanically predisposed towards compression fractures because we are changing from kyphosis to lordosis and that tends to load that into your body plus we are in the stability of the thoracic spine, mobility of the lumbar spine, and those junctional areas we know are very common areas to start to find fractures.

We see this craniocervical junction, cervical thoracic junction, and thoracolumbar junction. Those are where we see the predominance of a lot of our spinal fractures. With the thoracolumbar spine compression fracture, how does this happen? Same thing as we saw on the c-spine flexion and/or axial load. One of those was some of the classic mechanisms: I picked up something too heavy, I bent forward to pick up something too heavy and I felt a pull, heard a pop- instant onset of pain.

The nice thing about the spine compression fracture, I mean, the most common fracture, the good news is It is a stable fracture. When we deal with compression fractures because the middle column in the posterior column is still intact, these are stable fractures. The asterisk on that one is there is that caveat: if somebody loses 50% or more anterior body height that tends to indicate instability even in a compression fracture because there's probably some degree of ligamentous damage.

One of the other important considerations, when we are dealing with these fractures is once somebody gets a compression fracture where that vertebra takes on an anterior-wedge shape, that vertebra is going to be wedged forever. Then, we start to deal with the issue of, I see wedge-shaped vertebrae. Is this an acute compression fracture? Is this an old compression fracture? What's going on in this particular case?

When we look at how compression fractures occur, what is really interesting is only about a quarter of compression fractures in the TL spine are from acute trauma. The majority of these are going to be seen in patients that have some degree of lost bone density; whether it is due to post-menopausal or senile osteoporosis, or whether we are looking at secondary osteoporosis from, of course, one of those big culprits being corticosteroid medications.

If I have got somebody there, an athlete, they are dedicated to their life to athletic performance, but they can still have rheumatoid arthritis and maybe they need to take the chronic medications or long-term medications for rheumatoid arthritis. One of the standard meds used very frequently is corticosteroids. Of course, these days I try to wean people off corticosteroids as soon as possible and get them on other medications, but, we can still see where these corticosteroid medications can be a hallmark for the treatment of autoimmune conditions.

The big thing that we need to remember is, if I see a compression fracture, I'm dealing with a young athlete, they have had traumatic incidents. That is not going to be surprising. But I always want to make sure that I do investigate, how does this person's bone density look? What does their med list look like, to make sure there is nothing that might be diminishing their bone density. When we start dealing with compression fractures, it is the anterior 2/3 of the vertebral body that is involved, and because of that, what we are seeing up here in the top right image, we are looking at the standard wedge-shaped compression fracture. I know that It is just the anterior 2/3 involved because the posterior vertebral body has maintained a tight. It is still concave and the posterior elements are fine. That is the average run-of-the-mill compression fracture. That is what we see most

times. It is possible, particularly in osteoporotic individuals to see the biconcave or fish vertebrae style compression fracture, and this is where is the exact line drawn from the three-column theory of that as well. The nice thing is because they have maintaining posterior body height and it is still concave, most of these are still stable.

The other possibility again, typically, dealing with somebody who's profoundly osteoporotic or something that raises a concern for other underlying bone diseases, such as multiple myeloma metastatic disease; and that sort of thing is the vertebra plana where the person loses anterior and posterior vertebral body height and that can still happen during a compression mechanism. If it is a minimal mechanism, then we have to be concerned about a pathologic fracture.

Something I alluded to just a moment ago was any time we are looking at a compression fracture, we do run into the problem of that vertebrae going to be wedged, from the day the person gets the fracture until the day they die. Then, we run into this, is this renewer and old compression fracture? Well, one of our first rules in Radiology is, always compare with the previous imaging. If you have a patient that you know has previous Thoracolumbar Spine Imaging and they come in, they have got a new onset of pain and you see wedge-shaped vertebrae, look at the old studies. That is one of the best things that you can do. Back in the olden days, before the beard turned grey, that was not at most easy to do. Because if the patient had imaging done at another chiropractor's office, I had to wait and order those in. If they had them done at the hospital, I would definitely have to wait and order those in and comparing those images might take two weeks and that's a lot of waste of time.

These days with digital health records quite often I can have access to most patients' imaging within an hour. Comparing against previous imaging is much more user-friendly these days, and that is always something that's on my list. Have you had previous imaging? I like to pick on my experience having practiced in California. I mentioned that I practiced in a little town called Clovis, where the biggest event was the Annual Clovis Rodeo. Well, do you want to talk about somebody who experiences polytrauma? Rodeo clowns. That is where and quite often a nice thing about rodeo folks, It is they have medical records they bring with them. But comparing new versus old was always an important thing. Let us go into the I do not have previous imaging, not everybody walks around with spine X-rays in their back pocket.

I am going to look to see, does my patient have other findings to tell me if this compression fracture is new or if It is old? When I look at this long list of things, those three: a zone of impaction, paraspinal edema, and step defect. Those are my big three. Those are the things that really help me decide, is this an acute compression fracture? Because if I see any one of those three things, that is an acute compression fracture.

The other things, we got some variability there. We will talk about those in a little bit. Let us look at a patient. So I have given you a very focused close-up on this one. This particular individual, is an electrician and so he does a lot of manual labor. He does a lot of heavy lifting, in a lot of awkward positions, got a past history of spine injuries, and been to several chiropractors throughout his life.

Comes in after doing a recreational weekend of building a concrete patio and he had bent over to pick up an 80-pound bag of concrete: immediate onset of pain. You have got flexion, you have got an axial load, immediate onset pain. This definitely warrants taking some pictures, so, looking in this thoracolumbar junction, there is a wedge-shaped vertebrae, and realize about 10 degrees of wedging can be considered normal too, particularly in the thoracic spine. It is very common to see up to 10 degrees of anterior wedges a normal developmental thing. Here, we are looking at about 25% anterior body height loss.

As I close in on his lateral view, I see a wedge-shaped vertebrae. I have got somebody with heavy manual labor history. Is this new or is this old? Well, one of the first things I noticed when I look at the cortex on these vertebrae, is right there, you are going to take the lines away now. You can see that there is a sharp step defect in the anterior cortex. That is where the fracture line occurred. I see that sharp step defect and that step defect will typically go away in 6 to 8 weeks. It will start to round off as the body heals. I can see that sharp step defect, I already know that this is an acute compression fracture. This person also has a second finding. Look at

the yellow line I am going to make both things go away. There is a faint white line right behind that step defect and that is known as the zone of impaction. You will also see it described as the zone of condensation.

What is happening there, so if my fingers are trabeculae and the fracture line is right in between, well when that fracture happens, there is an impaction. Now we have twice as much trabecular bone along that fracture line and that creates that sclerotic margin. Again, that goes away in 6 to 8 weeks. I only need one of the three findings to tell me that it is an acute compression fracture. I have got 2 of the 3, so, I am comfortable saying, Tom here has an acute compression fracture, posture body heights maintained, the posture body still concave; posture elements look fine.

There is one thing you got to remember, compression fractures in the thoracolumbar spine, our diagnosis of exclusion. You must exclude other things like burst fractures and chance fractures first. What else do I see? The third finding is paraspinal edema. I want you to think back to gross anatomy. If you did cadaver work, or if you did digital work, one of the things that were kind of cool from doing the gross anatomy dissection is, once the ribs were cut and the heart and lungs were dissected out of the thoracic cavity, it was kind of cool to realize that when you look inside the chest, you can see the thoracic spine. But overtop the thoracic spine was a thin membrane of tissue. Part of that is the parietal pleura, part of it is the thoracolumbar fascia. Well, that is the paraspinal soft tissue stripe when we look at a radiograph. Normally that paraspinal stripe should be very close to the vertebral bodies of discs. It is almost like celery skin that is very, very thin. We can see that radiographically quite often.

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Less than 2 millimeters is kind of our threshold thickness. Well, not surprisingly, if somebody fractures vertebrae there's going to be soft tissue swelling in that area. One of the things that we assess is we look at that paraspinal stripe. In this case, we can see where the paraspinal stripe is displaced. Now we get rid of the ink. An important thing is the only place that we can see the paraspinal stripe is T12 and above, and only on an AP thoracic spine. Because that is where we have the patient do a full inhale to get the lungs as long as possible if the diaphragm's down.

On the lumbar spine, when you have exhaled to get the diaphragms up, it tends to obscure that thoracolumbar junction. So, we are really going to only see this T12 above because you have to have the interface between the lungs and the vertebrae, and generally, only on an AP thoracic. But in this case, I can see that distention of the paraspinal stripe. So that is the swelling that confirms absolutely, I am looking at an acute compression fracture.

What if I do not see those things? Because here is the problem, because there is always a problem. Well, the problem is, if I see a step defect, a zone of impaction, or paraspinal edema, I know it is an acute compression fracture. They are great when they are there, but sometimes, they are not there, and it is still an acute fracture. That is where I must start looking for some other secondary criteria, or I will have to start thinking about some advanced imaging. I will talk about it momentarily. If this patient comes into me and I am looking at this radiograph and I see wedge-shaped vertebrae and I am worried this is an acute compression fracture or not; I am pretty sure this person has an acute compression fracture. Because I am seeing something called abdominal ileus. Well, and what abdominal ileus is? It is a pain reaction. When somebody is in really bad pain, not surprisingly, when we look at the sympathetic versus parasympathetic tone.

When I got somebody who's in really bad pain, their sympathetic system activates. As your sympathetic system becomes high tone, your parasympathetic becomes low tone. What happens is peristalsis stops. Digestion is a parasympathetic reaction. Well, if my peristalsis is stopping because I am in so much pain, one of the things we see is all the methanogenic bacteria in the person's gut have more time to work on the bolus of food and then make more gas.

If you look at this person's lumbar spine/abdominopelvic radiograph, there is a lot of gas in there. This is somebody that if you were to tap on their abdomen, they will be hyper resonant. They sound like a kettle drum because they have so much gas in there. Is it an indirect finder? Yes, it cannot be one-to-one because it depends on a person's pain thresholds. It also depends on the person's diet, and it depends on the person's colonic

activities. When we start seeing these things, I am pretty sure that this person has an acute compression fracture. But let us talk about your diet and some of your bowel habits too.

One of the other things to consider and this is one, we always must think about in trauma cases. We tend to focus on the broken bones, not surprising because that is what we see on an X-ray. One of the things that I really try to reinforce in how we think about these fracture cases. We were thinking about fractures. Rather than fracture, think about them as trauma, and one of the things to really focus on is if there is enough force to break a bone, there is going to be soft tissue injury in the adjacent spaces. We should always be considering the soft tissue injuries because realistically bone heals really well. Ligaments, not so much. Discs, not so much.

Always think about what are the associated soft tissue injuries that we might be dealing with in this patient. If I have got somebody who is got a traumatic thoracolumbar spine compression fracture, you cannot break vertebrae without injuring at least one of the adjacent discs, if not both. So, one of the other things that I look at to try to help me decide if a wedge-shaped vertebra is a new compression fracture versus an old compression fracture, is how much degeneration is there in the adjacent intervertebral disc spaces. In this one, of course, I can see the step defect in the zone of impaction. But there is no degeneration. Pristine-looking disc above, pristine-looking disc below. When I look at this wedge-shaped vertebra, lots of degenerative changes above and below. If I come down to this disc, it looks pristine. This is an indirect indicator. There are a lot of factors that involve polytrauma age.

If my person is 80 years old is that really going to be that terribly useful if I am dealing with a geriatric athlete? That might be a difficult thing to consider. Again, an indirect indicator might be useful. What if I am still not sure? I do not have old films for comparison. There is no step defect, zone of impaction, paraspinal edema, no real substantial degenerative change around, but it is a young individual. Have they had time? But I am still not sure. They got pinpoint tenderness, their pain scale was 8 out of 10. I am worried that this is an acute fracture but the X-rays are not helping me. It is time to think about 2 advanced imaging options. There are really three, CT, bone scan, and MRI. I will be honest with you that for compression fractures, I am not jumping on the CT for this one. Can it be useful? Yes. But there are some dependent features so, could I? Sure. What about a bone scan? A bone scan is an option. We see in this person, that there's an L2 biconcave vertebrae.

When somebody has a fracture that is going to increase metabolic activity in that bone, so, it will increase the radiopharmaceutical uptake on a bone scan. We can see there is definitely increased uptake in L2. Well, here is the problem, and why a bone scan is not that much of an option for me either. Because a bone scan can be hot for up to two years after a fracture.

Because of the intense remodelling that goes on, because of the accelerated degenerative changes, bone scans will definitely be hot the date the fracture happens. But there is also that concern, this can be hot for up to two years. Bone scan, again, like CT, it is an option but it is not a favorite option. If I really am not sure and I am trying to figure out, is this a new compression fracture or is this an old compression fracture? I would much rather get an MRI.

The MRI is going to be much more definitive, plus I will be able to look for additional things, looking for disc pathology. We can see wedge-shaped vertebrae here at L3 .Let us consider that I do not see the step defect, I do not see the zone of impaction. I am not sure. Is it new or is it old? When I look at the MR I can see the bone marrow edema on the fluid-sensitive sequence, I see the decreased signal on the T1. That goes away 6 to 8 weeks, so, I know that I am dealing with an acute compression fracture. On the outside, the marrow edema might last 12 weeks. So, that is a really more useful modality. The other thing that has to be on my differential list when I find wedge-shaped vertebrae, and this is particularly important if you are going to be dealing with juvenile athletes, is the possibility of Scheuermann's disease. Now with Scheuermann's disease, this is osteochondrosis. We are seeing a problem with bone and cartilage and also known as juvenile kyphosis. What we are seeing here is this person essentially gets inflammation of the endplates, and that inflammation of the endplates, there are a couple of major components to this. There is a strong familial incidence of Scheuermann's disease. But we also see this much more commonly not surprisingly in students with chronic repetitive spinal trauma. If we get children that are getting into heavy-duty powerlifting a little too young, we can see this in

gymnasts' workhorses. They have very mobile agile spines, doing lots of axial loading with floor exercises and that sort of thing. Not to mention just landing from uneven parallel bars and so forth, puts a lot of force through the lower thoracic lumbar spine.

What we will start to see is it creates an inflammation of the endplates and that inflammation of the endplates results in remodelling of the vertebrae, and what we see, the major diagnostic criteria for Scheuermann's is a bullet point number 1: 3 or more segments with 5 degrees or greater anterior wedging. That is exactly what we are seeing here. Wedge, wedge, wedge, wedge, and there is this hyperkyphosis in this region.

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Not surprisingly, because of the endplate component, we will see that the person will have some Scheuermann's node formation. They can have some endplate irregularities and because of the wedging, there is definitely going to be a hyperkyphosis.

When we see the child that has active Scheuermann's disease, that might be different than the adult that has the residual deformity from Scheuermann's disease because that wedging stays forever. It does tend to make the thoracic spine more rigid having experienced several patients with Scheuermann's disease. This is one where I see that hyperkyphosis in younger individuals through the mid-30s and 40s. It is fairly rigid on palpation. I am thinking, could this be Scheuermann's? Absolutely, but the other thing on my differential list is Ankylosing spondylitis, enteropathic arthritis, psoriatic arthritis, and reactive arthritis. So those are patients I tend to image to see, is this an inflammatory arthropathy? Is this a developmental abnormality like Scheuermann's disease, or is this personal hyperkyphotic because they have a single-level compression fracture? Next on my differential list is the burst fracture. With a burst fracture, also flexure or axial load mechanism, same as we have seen previously, the difference being more force, and one of the concerns is when we find these fractures, these are unstable because a burst fracture by definition involves 2 or possibly 3 columns, usually, 3 to be honest with you.

What is interesting is when we look at the burst fracture in the thoracolumbar spine, it has lower incidents of neurologic injury than the cervical spine, and it is because we are getting out of that corded region if we are into the lumbar and learn to cauda equina which tends to be able to shift out of the way. Also, something I am not going to discuss because the likelihood of seeing an acute chance fracture is very low. It is another three-column unstable thoracolumbar spine fracture. But the big idea when we are looking at the thoracolumbar junction is, compression fracture is a diagnosis of exclusion. We make sure that the wedge-shaped vertebra is not a burst fracture or remote possibility of chance fracture before we say that it is a compression fracture.

What do we see? These are going to have anterior wedging, but more importantly, there is going to be middle column involvement. You can see on this MR, where this person has that posterior for tibial bowing. Looks like a compression fracture anterior wedging. Middle column involvement, middle of body height loss or posterior convexity, and then quite often these will involve all three columns, so we are also going to see a vertical fracture on the posterior elements.

One of the things that vertical fracture on the posterior elements can do is spread the pedicles apart. So, we will see an increase in the interpediculate space. Now, chance fractures again. Chance fractures are really rare and not going to address those. They have a horizontal splitting. As we take a moment and look at our two-view thoracolumbar spine radiographs here. When I deal with spinal imaging, I always start on the laterals. The laterals are kind of our high-yield area when we are looking for spinal injuries. As I start running through there, I can see, there is definitely anterior wedging. The person's actually taken a fragment off, the rest of the body looks okay, posterior body height, still nice and tall. Now, there is a little spondylolisthesis here but it is trauma. Sondylolisthesis can happen with that. But the posterior body is nice and tall; posterior body still concave.

Here on the lateral right now, I am thinking this is a compression fracture in L2. But when I look at this over on the AP view, one of those, I do not pull out rulers very often, I do not do a lot of drawing on my X-rays. But I eyeball the space between the pedicles. As we go down the spine, the space between the pedicles is supposed

to get gradually bigger each step. Problem is, when I look at this person from T12 to L1, they got a little wider. L1 to L2 got a lot wider and then L2 to L3, all of a sudden became narrow. That is a problem.

Well, that means that L2 got too wide too fast and that is the spreading of the interpedicular distance that indicates a vertical fracture through the posterior elements. Even though this looks like a compression fracture on the lateral, it is actually a burst fracture. These are unstable spinal fractures, so this is a backboard and transport case. When we look at these burst fractures, the thing that we are most concerned about, when we look at these burst fractures, is this retropulsion of fragments. You can see where the fragments have been blown backward into the spinal canal. But again, because we are dealing in a more cauda region, rather than a corded region, things are able to move out of the way a little bit more, and another slice on the CT on this one shows the vertical fracture through the posterior elements that resulted in the spreading of the pedicles, that this pedicle can actually faintly see a fracture line extending through here. It is not really connected to the body and it is allowing for that lateral displacement of the pedicle in this case.

Not surprising when we are dealing with these burst fractures, if there was any suspicion of a burst fracture, we have it more on field in patients getting altered sensation in the lower extremities. Naturally, this is going to be a backboard in transport for imaging. What is interesting is these patients, because there is a lower incidence of neurologic compromise, there is the possibility of these being ambulatory patients. Maybe they had the athletic event over the weekend, they injure themselves but they delayed going in to see anybody. You know athletes, they can put off a little bit of pain. So, they put off the pain until eventually come in, I will go see the doc on Monday. We might take the imaging, find the injury, and then we'll have to transport the patient from there.

Other things that can happen in the thoracolumbar junction Schmorl's nodes. Incredibly common. Now, what we see with the Schmorl's nodes, is an intra-vertebral disc herniation where the nuclear material breaks through the endplate and herniates into the vertebral body and we will see it contour change the vertebral body. Most Schmorl's nodes happen during the pubescent growth spurt, you get somebody who is growing really fast or some naturally weak areas at the endplate and allows that to occur in generally, the person never knows it happens. They have no pain. They have no problems. We take X-rays; we see Schmorl's nodes. It is possible to have the Acute Traumatic Schmorl's Nodes. This is a very small subset of Schmorl's nodes.

Unfortunately, I cannot get this X-ray and tell you if these are new or old. Where old imaging might be useful, is you can always compare with previous imaging. Or focal pinpoint tenderness, that spine is really lights-up, the person has an axial load trauma. Could this be an Acute Schmorl's nodes? I will get an MRI. The MRI will show me bone marrow edema and that will help me figure out that it is a new injury. But again, these are very uncommon and they're unlikely to change how management is done aside from some rest; I do not know that I'd necessarily go to that degree.

Some of the things that we also have to consider on our differential list when we are dealing with thoracolumbar trauma. If you remember the burst fracture case that we just looked at a minute ago, there was a small triangular fracture fragment that got knocked off the corner of the vertebrae. Well, one of our differentials on some of these cases is something like a limbus bone. These most commonly happened in the thoracolumbar spine. Well, how am I supposed to tell if that is acute fracture or if it is a limbus bone? Well, in my classes here at the College, I teach a mantra of always ask yourself this question, repeat this, repeat it, repeat it, repeat it. Does it have smooth, well-rounded corticated margins? If something has smooth, well-rounded corticated margins, it is been there for a long time. It is not an acute fracture. When I look at this triangular fragment here, it has smooth, well-rounded corticated margins and it is fitting like a puzzle piece. That is a limbus bone.

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Limbus bones do come in a couple of different flavors. There is the anterior limbus bone and the lateral limbus bone on the posterior. The anterior, most commonly asymptomatic. Laterals the only place I have ever seen those reliably is on a CT, they're not common. The one that we worry about is the posterior limbus bone. These can occur traumatically, it is possible to shave off a corner of a vertebral body. When we look at the posterior limbus bone, this is a middle column fracture. This is one of the few exceptions to our three-column theory of

Dennis, and what we are seeing is where the person fractures off the posterior body corner. As we deal with these, one of the concerns and we are dealing with the posterior limbus bone is, it doesn't look like much of a fragment. You can see where this one was from the corner and then displace backwards. This will create some degree of spinal stenosis because of that displacement going backward, it does go into the spinal canal. I will evaluate that patient for stenotic symptomatology and treat them accordingly.

What else can we break in the thoracolumbar spine? The fantastic fracture that occurs with flank trauma, not really fantastic but something occurs very frequently with flank trauma is the transverse process fracture. When we start thinking about thoracolumbar spine transverse process fracture, I want you to reach back, reach behind you, palpate your transverse processes for me. Transverse process, it is a little piece of bone, It is really super thin. What is interesting is, if you have any access to dried specimens, when you look at most dried vertebral specimens, you will notice that a lot of them do not even have transverse processes because they tend to break off really easily when we look at those dry specimens. I think, well it must not be that hard of a thing to fracture. Well, except there is a lot of giving them as living bone and how many of you were actually successful in palpating your TPs? I remember, they told us to help palpate mammillary processes in chiropractic school. So why cannot I palpate my TPs? Because they are covered by 4 to 6 inches of paraspinal muscles. We have 4 to 6 centimeters of paraspinal muscle and soft tissue on top of these. It takes a lot of force to fracture a thoracolumbar TP. So flank trauma is the biggie.

Some of those good mechanisms, how to get flanked trauma like this, the Peloton. If you get a bike that goes down in the Peloton and a whole bunch of bikes starts going over on top of each other. You are going to get people that are the bikes are flipping, they're landing on their back, that is a flank trauma. One of my favourite sports, this is one that it was a sport that I never really knew about when I was in high school but then my son started to play it Lacrosse.

Lacrosse is a fantastic event when we start talking about flank trauma. Because let us take a bunch of testosterone laid in young men and give them metal poles and tell them to beat on each other with them. Not surprisingly, there is a lot of flank trauma that happens in Lacrosse. So, when we start dealing with this: somebody has flank trauma, something hits the flank region. We can also see this in other things. These can be injuries and hyperflexion, hyperlateral flexion.

We can see them with an event impaction component with extension injury. There are all kinds of mechanisms and flank trauma is the biggie. Let us take some pictures. Obviously, there is a fractured transverse process, fractured TP. One of the other things that should make us worried about this is asking them the right questions. Somebody's got flank trauma after an event, after an accident. Any problems urinating, are you noticing any discoloration in your urine?

My middle son, Cody, is what I like to pick on a little bit here for sports injuries. Well, Cody played Lacrosse and he was a good player. Not quite as good as he thought he was, but he is a good player. One game, the other team is all on top of him, just wailing on him with a stick. He was complaining a lot about the pain after the game. I was not surprised, and about two hours after the game, there is a blood-curdling scream out of the bathroom and my wife and I run in to see what is going on.

Well, if you look in the toilet, it looked like cherry soda, cherry Kool-Aid, cherry juice, because he was having gross hematuria. They had bruised the dickens out of his kidney. His kidney was really bruised and because of that, he had hematuria. So naturally, we took them off and got Abdo CT, no TP fractures in his case. But what it does illustrate is anything that has the possibility of fracture and transverse process, also has the possibility of damaging the kidney or the ureter, so watch for hematuria. But what is really interesting is when a kidney gets injured, one of the things that can physiologically happen is the ureter clamps down below it, and the person might not actually get gross hematuria.

If I find TP fractures radiographically, I know I am getting an Abdo CT. If I have got a patient with hematuria, I know I am getting an Abdo CT, because they need to evaluate what's going on in this case. One thing to realize some of these fractures are also small and subtle. So, we can see here that there is a TP fracture of this one It is subacute, there's some callous around it. The X-ray was completely normal on this case. I never saw the

fractures. But one of the things that this does highlight is when and unfortunately, we are looking at a bone window here, not a soft tissue window. Here is psoas, this is the kidney up here, and if there is enough force to go through that thick paraspinal musculature to fracture the TP, that force is probably going to be enough to go forward and hit the kidney. We always worry about renal and ureteral injury when we are looking at TP fracture in the TL junction. Automatically goes to an Abdo CT.

This would not be a complete topic in talking about lumbar spine injuries without also addressing the idea of the spondylolisthesis. As we look at spondylolisthesis, we are seeing those vertebral slippages, remembering there are five major types for spondylolisthesis: Dysplastic, Isthmic, Degenerative, Traumatic, and Pathologic.

I am going to talk about isthmic. Traumatic kind of makes sense. We have already talked about things like unilateral and bilateral dislocations. When I talk about isthmic that is what I am going to focus on here for our next little bit the isthmic spondylolisthesis. This is a problem of the pars interarticularis, which literally translates the part between the facets.

When we look at the pars interarticularis, it is an inherently weak area in the spine. In the thoracolumbar spine between the facets, the bone tends to be fairly thin and what's really interesting is, there's actually a large, genetic component to how thick a pars is. We see some populations have a much higher incidence of fractures of their pars than other populations. Not surprisingly, this generally most commonly involves L5, but It is possible to see pars defects at any level in the lumbar spine, and when we start looking at these, what happens to the pars? There are actually three different possibilities of things that happen to the pars.

The first possibility is that there is a fatigue fracture that heals non-union and allows for the slippage to occur. There is an elongated pars and then there is an acute traumatic pars fracture which does not happen that often. These are very common as chiropractors. We all see these pars defects style spondylolisthesis. All the time and practice incredibly common kind of thing. Now what is interesting is it used to be thought that this was a congenital anomaly, you are born with a defective pars. They have never seen this in newborn infants. But the current thought on this one is the type of a fatigue fracture. I will talk about that momentarily. One of the terminology things and this is probably as much of a pet peeve of mine, as anything else, is the number of people who call these pars fractures. The etiology, how does this happen? It happens because of a pars fatigue fracture. But that pars fatigue fracture, typically happens in people between 10 and 15 years of age, and then it heals non-union, and then it is two separate distinct pieces of bone.

The term fracture implies acuity. I prefer to not use the term pars fracture unless I am dealing with an adolescent with an active fatigue fracture. When we are dealing with a 35, 45, 55-year-old individual who's got a spondylolisthesis, it is better to use the term pars defect rather than pars fracture. When we look at how often this happens, it happens fairly frequently in an athletic population, somewhat sport dependent. I will talk about the different athletic activities here in a little bit. Generally, in the general non-high-grade athlete population, two and a half to 5% of the population has an ethnic spondylolisthesis. When we start looking at athletes, we can see up to a 17% frequency.

Now, we get back. For the two to 5% of the general population, a lot of its related to genetic predisposition in the thickness of the pars and how much it can bear load, and when we look at athletes. It is because of higher grade athletes repetitively stress that area. What occurs, how does this happen? What we are looking at is what I like to refer to as a series of unfortunate events. What we are seeing is where we have got an adolescent patient, and again, 10 to 15 is our first standard deviation for where this occurs.

This adolescent patient is doing some type of activity with hyperextension. They are repetitively hyperextending the lumbar spine; and with that repetitive hyperextension, they eventually fatigue fracture the pars interarticularis. Fatigue fracture, stress fracture, interchangeable terms here. They stress fracture that pars interarticularis and then they keep doing their event, and as they keep doing their event while they are not giving that a chance to heal so that fatigue fracture becomes a complete fracture. Then it heals up as two separate bones, and that is what allows the vertebral body to start to slip.

What kind of sports are involving this hyperextension activity? One of the phrases that I like to use for this one is, these are people who participate in "ta-da sports". Where at some point in time during their thing, they go "ta-da!" and they are hyperextending as a part of the event. Gymnastic floor exercises, gymnastic landing exercises, almost everything involves hyperextension. When we look at high divers, the best way to get smooth laminar flow into the water with a minimal splash hyperextension of the low back, so you have got that lordosis.

Video Presentation Placements: 41:15

One of the things that is kind of interesting is when I talk about cheerleading as being a major athletic event that has a lot of injuries here in the US. Cheerleading is actually the number one, high school sport and college with significant injuries. Because we are taking people and throwing them high in the air and hoping somebody else can catch them and a lot of repetitive activities.

The whole idea though, is something in this act and this is not an exhaustive list, there are a lot of different sports that involve that lumbar hyperextension. But that repetitive hyperextension, they keep going back, they keep going back, they get that fatigue fracture. Because they are high-grade athletes, they ignore the pain and work through it. That is what allows this thing to heal up, non-union, so what am I supposed to do? I have got this adolescent athlete and they have got back pain and it is focal. When I am palpating and I am going down the articular pillars, I get down over L5 most commonly and they just light up. We need some imaging. We are going to start with an x-ray, but one of the things that you have to remember is stress fractures are hard to see on an x-ray, and there is also a long radiographic latent period, it can take up to three weeks before anything even shows up on the X-ray. There is a long latent period and difficulty in evaluating.

If I have got an athlete who is doing an extension event and they got back pain, I will take the x-rays but I know I am probably going to end up in an advanced imaging tool, and the thing that we really want is we really want MRI. MRI is the preference these days. For a long time, we talked about doing spect, which is a kind of a CT bone scan combination. It is good, spect is okay, but it is a high radiation dose to an adolescent patient so we would much rather get the MR. MR will give us all the same information and a lot more besides, so I would rather get an MRI.

What about things like obliques? I will be honest with you, I am not a huge fan of obliques. Never like them that much. Can they be useful? But do I like them that much? No, not really. But would oblique show me? Well, if I am really lucky, I might be able to see the pars defect, and of course, that is where we talk about the Scottie dog. It is the collar of the Scottie dog is the area of the pars interarticularis. Normal one is outlined, pathologic one below.

Realize L5 is not always easy to see on the obliques. I will be honest with you. Do I even need the obliques? We will look at the minimal series. If I look into this patient, do I need obliques to figure out that my person has pars defect? No, it is right there. Drive a truck through that thing. What are obliques going to tell me? There is pars defect, clear the minimal series first. I do not do obliques unless I have to.

Is this actually a pars defect or is this an elongation? We are looking more at the type 2B? I am not sure. Could I do obliques? Sure. Do I want to do obliques? Not really. I mean I know there is a spondylolisthesis. I can see that there is a step defect in the spinous processes and in this patient that was actually what prompted the radiographs. This patient is a rock climber, was a cheerleader, was a high diver in high school. Lots of things with chronic recurrent, low back pain. She had like six percent body fat. When you palpate her spine you can actually really palpate her sinuses. She had a big step defect so it prompted taking some radiographs. She's definitely got a spondylolisthesis there, but I am not sure, is this a 2A, or is this a 2B? So, what I would much rather get rather than a set of obliques is, I would much rather get a Ferguson's.

Ferguson view, is so much more worthwhile when it comes time to evaluate the pars at L5, and I can see that there is a pars defect there, and there's a curvilinear pars defect there. In this case where I was questioning, is it a 2A or 2B? The Ferguson view is definitely worthwhile; much better than the obliques. Could I do oblique stir different patients? No reason to do the obliques when I did the Ferguson's of that one. Realize that L5 part particularly on somebody's hyper lordotic can be difficult to see. One of my big recommendations from a

technique standpoint, if you are doing your own radiographs in these patients, make sure that you do your oblique lumbars P to A instead of A to P. That way you are taking account in the divergence of the ray and help you with lordosis.

What if I am dealing with that adolescent patient? They've got focal tenderness, the x-rays were negative, but I am really worried that there's an active stress fracture going on. Get the MRI and one of my requirements for spinal MR, when I talked to the imaging centers that I utilize for doing spinal MR, I won't utilize an MR Center, unless when they're doing my spines. We know that there's the T1s and the T2's. One of my requirements is and this is a standard protocol for most places: they have to do a sagittal stir or a sagittal fat sat. I want one of those really fluid sensitive sequences in the sagittal plane.

Because it is what really shows up a lot of pathology with edema, and in this particular case, different patient. In this patient at L4, we are looking at a stir and there is very high signal intensity in that area of the pars and the pedicle and coming down into the inferior facet. This is somebody that has an active fatigue fracture. Their radiographically normal, but there's bone marrow edema. This is an active fatigue fracture. This is a patient that if I can get this person off activity, get them into a Boston Brace, take out that lordosis so that they're in an anti lordotic position, give it six to eight weeks to heal. It is probably going to heal so that they won't have those issues of developing a spondylolisthesis. Because one of my concerns is, you know, is this thing going to progress? Is this thing going to be unstable? Luckily not many spondylosis progress, but the greatest probability progression is within two years of the fracture. I want to make sure that I am getting this person as young as early on in as possible. Try to keep them from actually even developing the spondylolisthesis.

In the patient that I showed you previously that has a rock-climbing gymnast high diving history. She's an adult patient. She's in her mid-20s. One of my concerns on a patient like that is for instability particularly because she has chronic recurrent back pain. Again, instabilities not terribly common when we deal with spondylosis because a lot of times that even though it heals non-union, there's fibrous connective tissue in the area. But things that make me concerned for whether or not this might be an unstable spondylolisthesis. If I notice a trapezoidal shape to the L5 vertebral body, where if I look at the anterior body height and I compared it to the posterior, posterior's, a lot shorter. That makes me a little concerned for whether or not my patient has potential instability.

We can also see this patient has a trapezoidal shape to L5. So anterior, body height, posterior body height, also have a lot of rounding of the lower segment, and one of the things being that, if this vertebrae keeps slipping back and forth, it might be eroding to some degree that lower segment. I am concerned about this person being unstable. I will think about doing flexion-extension radiographs, realizing that it has, this segment is unstable, that celebrates degeneration.

We start to see osteophyte formation and that osteophyte formation creates something called sacral buttressing, and it is where the osteophyte is growing underneath that segment as an attempt to stabilize. The big thing to think about when I am dealing with the spondylolisthesis case, is it stable or is it unstable? We'll worry about getting flexion-extension radiographs in a point in time.

If you get that patient who keeps doing their repetitive hyperextension event over and over and over, ignoring the pain and pushing through, they are going to get a type 2A where the fatigue fracture becomes complete. The complete fracture heals, non-union, it allows vertebral slippage. What if you get the athlete, who is a little bit more cognizant of using pain as a guide and they do a hyperextension event and then eventually develop pain and then they lay off for about a week or two? But then they go back to their event and then it starts there and then they take a week or two off and they do this repetitive cycle of injure and partially heal and injure and partially heal.

One of the things that that can do is that can create a Wolff's law, elongation of the pars interarticularis, and allow that vertebrae to slide forward. But the pars are still intact, so on an MRI would show up as a demodus on x-ray, we might not that we would not see anything except some progressive elongation.

That is one of the other causes and then the acute fracture. The pars does not like to have the acute fracture. This does not happen so much, but it takes some kind of massive, hyperextension force. This is where I will pick on American football as opposed to International Football. When we look at American football, if you get somebody who throws a shoulder pad into a low back, that can create a lot of hyperextension injury. A 250-pound linebacker against your lumbar spine, probably not a great choice. But any kind of acute hyperextension, acute onset of pain. The concern here, is this actually an acute pars fracture? Problem is an acute pars fracture, it is hard to see those smooth or undecorticated margins, so going to an MRI or CT is really going to be a good option for that.

What is also interesting is It is possible to get a fatigue fracture on just one side instead of having the spondylol and the other term for that is spondylolysis. Instead of getting it on both sides and allowing the vertebra slip, you can also see it on one side. The vision I put in my head is somebody who's doing an asymmetric extension exercise. Things like high jumpers, pole vaulters are the kind of pictures that come to my mind for these. That is where they are going to one side for their event. They always go to the same side, not surprisingly. They fatigue fracture that side and it heals up non-union. But the other side still intact. Typically, with a unilateral pars defect, they do not get vertebral slippage. But what we might see when we look at this patient is, we might see a unilateral sclerotic area of the pars and facets.

Video Presentation placement: 52:16

Ferguson's view would be my preference on this one. On this particular case, I happen to have a set of obliques, I can see there is a pars defect on this side. There is no pars defect on this side, but it is extra sclerotic. Now, this is where we also have to think differentially. If this is our adolescent athlete, we have got somebody who is 15, 16 years old and they are complaining about an insidious onset of back pain. One of the other things that is on my differential, when I look at this really densely, sclerotic pedicle pars area is we have to think about one tumor, in particular, osteoid osteoma. We can also throw osteoid blastoma on our list. If I have got that adolescent patient, who is got this insidious onset, back pain, regardless of sporting event, and then I take an x-ray and I see that there is this one sclerotic pedicle/pars. I know that I am going to an advanced imaging tool. I will be going to either a CT or an MRI. I will be honest with you. This is where I would have a preference for a CT to give me better bony resolution of that area, to see if there is osteoid osteomyelitis or an osteoid blastoma tumor mass to make sure that this is actually a unilateral spondylolysis.

We continue on down, we are now going to get out of the lumbar spine and drop down into the sacrum. As we start looking at sacrococcygeal injuries, a couple of big categories of things. The acute traumatic fractures, vertical sacral fractures, horizontal sacral fractures, sacrococcygeal fractures, sacral stress fractures, very common in athletic populations, also very common in geriatric populations. When we start looking at these sacral fractures, we will go to the traumatic ones and we will talk about the stress fracture. How do you fracture a sacrum? Land on it. We can see a couple of different possibilities: either falling from a height or landing on one foot, landing on one ischial tuberosity puts a vertical shearing through the sacrum. You can see falling directly onto the buttocks and you land on the point of the sacrum/coccyx, and that can create a fracture.

When we start dealing with stability, stress fractures are generally stable. Vertical fractures, potentially unstable horizontal fractures are stable. The stress fracture, we really do break stress fractures into two categories, there is fatigue fracture and insufficiency fracture. A fatigue type stress fracture is healthy bone, abnormal, repetitive stress, the bone fails. Great one for this marathon, any kind of heavy-duty, long-distance running is where we talk about stress/fatigue.

Insufficiency fractures are abnormal bone and normal stress, and as we tend to talk about our geriatric athletes, who have diminished bone density due to menopause or age-related testosterone drop off. When we are looking at these, and this particular individual had always been a runner and they've done some long-distance running most of their life, they jog for fun, decided to do a marathon. Had never done marathon distancing before, and kind of got the bug at the last minute for an open marathon. Really ramped up activity in way too short of a period of time, started to develop sacroiliac pain.

Not surprisingly, because Murphy's Law being what it was. This is the spouse of a chiropractor and the pain started getting worse and it was SI. Talking to her spouse getting the SI joint adjusted. It is getting, you know how it works, whenever you adjust your spouse and all it seems to get worse. Maybe It is just my spouse. Maybe I am not that good of a chiropractor. This is not like my wife by the way. The pain is getting worse, so they decided, let us get some x-rays. They take some x-rays, they send the x-rays into meter reading. Everything looks normal. I know the history on this particular case. I know that this person has been ramping up activity, getting ready for an event. There is always a good possibility that you are dealing with stress fracture. We should really get an MRI to see what is going on.

What is interesting? Being this particular patient also worked at an Imaging Center and the MR was backed up. They talked to the radiologist there and they decided to get a CT instead. On the CT, we can actually see right here in the sacral ala. There is a nice area of sclerosis in the sacral ala, problem is, this is a mid 40s, female with a family history of breast cancer and we are seeing a plastic thing, so that became a concern. So then got the MRI instead and what we are seeing here. There is edema surrounding that area and this is a classic stress fracture in heavy-duty runners. It is a vertical sacral ala stress fracture because the repetitive heel strike puts a lot of vertical force from the sacrum. This is one of the things that has to be on your differential list for long-distance runners that have SI joint style pain. In this particular individual, we can see that there is a severe degree of osteoporosis, and with that osteoporosis, we are seeing a kink in the cortex up here at S and the junction between S1 and S2. The concern in this particular casem this was the onset after a kind of a hardcore weekend of gardening, which can be its own sport. So, a hardcore weekend of gardening, this person started getting a lot of SI joint pain. Do not like the shape of the sacrum and when we look at the MRI, we can actually see that there is bone marrow edema in the sacrum where this person has an insufficiency fracture.

It is also something that can happen quite frequently in our geriatric patients. They will actually get a combination of bilateral, vertical, sacral insufficiency fractures and a horizontal fracture, and it creates that H-shaped pattern on bone scan. This is called the Honda sign because it'll show up taking an egg shape pattern.

The horizontal, sacral fracture again, what do you do? Give you a fall. Maybe you are not even an athlete. Maybe you are just walking between athletic venues for winter sports and there's an icy sidewalk on your feet, go up and you land on your tush. Well, one of the things that we can see in these patients is a fracture of the distal sacrum or coccyx, and these are horizontal fractures, they are usually below the level of the SI joints. Not a whole lot to do for these. It is the management of most of these horizontal sacral fractures is to sit on a hemorrhoid pillow and try to take some pressure off the sacral apex. The big thing we are looking for here is on the lateral view, look for the offset in the anterior cortex.

Realize sometimes, this is a difficult area to evaluate. So also make sure you look at the space between the sacrum and the rectum, and the rectum should be pretty close to the sacrum. If this fractures though, it will create hematoma and can displace the sacrum or the pre-sacral space forward.

Video Presentation Placement: 59:25

The vertical sacral fracture, usually a higher velocity force landing on either a buttock or landing on your feet, asymmetrically. One of the things that we always want to look very carefully at is. look at those anterior, sacral foramina and as we look at the anterior sacral foramina, here, you will see that there's a jog it will offset. That is a vertical sacral fracture, and the concern is that can be an unstable pelvic fracture or it can progress to an unstable pelvic fracture. This is one where the person is going to most likely be managed pretty intensively. What is interesting is the coccyx itself does not fracture that often. Well the coccyx cannot fracture. Of course it can, It is a bone, but it tends to move out of the way a little bit and we see more. Sacral coccygeal joint injuries or horizontal, sacral fractures rather than a true coccygeal fracture. I realized this is super blurry and pixelated but there is a little offset in the coccygeal cortex. Person's going to be sitting on a hemorrhoid pillow.

Realize that some of these sacral fractures, coccygeal injuries. They can hurt for substantial time afterwards, and as an added side on this one, there are stress coccyx views to do. If you got somebody who's got coccydynia, having fallen down and they have got persistent pain for time afterwards, it is absolutely possible to de-stress radiographs. One is done standing, the others are done sitting, leaning back so you are right on the apex of the

coccyx and you are looking to see how much angular motion occurs. It is not that frequent but if you Google it or do a pub med search. You'll find several articles about coccydynia and hypermobility.

We are going to end off this lecture talking about thoracic cage injuries which we break down into rib fractures versus sternal fractures kind of our big things. A thing to realize about rib fractures, they are incredibly common and also one of the most common radiographically occult fractures in the human body. These can be very difficult to see and one of probably the single, most important thing when we started talking about it.

I have got a patient who has got thoracic cage trauma and they got pinpoint tenderness. Do not rely on a chest x-ray. This is unfortunately what we see a lot of times in an emergency department is to do a chest x-ray, read it, clear and send the patient on their way because there's nothing that is going to kill the patient.

This is where, if you are really worried about rib pain, make sure you get dedicated rib radiographs. It is not a thoracic spine with an open collimator. It is a dedicated rib study, you are doing a hemithorax. Depending on where you are looking, inspiration, expiration. You are also going to look at your frontals and obliques. Make sure that you are getting dedicated rib studies in patients with rib pain because these are incredibly difficult to see.

One of the most common radiographically occult fractures, and what we do when we are starting to look a rip for ribs., Upper ribs do not fracture that often we can see it in some heavy-duty events. Some of the throwing events, golfing if you've ever golfed as badly as I do. Because really, I do not golf, I excavate, I did a lot of holes, you can get a lot of upper rib pain, a lot of sternoclavicular pain. Here we can see that there is some obvious offset in the cortex on the cervical spine radiograph. Again, do dedicated ribs.

The big thing is we are looking at ribs. There are frontals and obliques. Obliques usually show you the entire length of the rib and the important thing is to trace the superior cortex. You trace that Superior cortex by looking for any kind of cortical offset as an indicator of fracture. You do not want to trace the inferior cortex. Because the problem there is, you got the area of the rib flange, really thin bone, and it can be difficult to see. We can see that offset in the cortex here. There is a rib fracture. In this case, there is also a rib fracture there. We are not seeing a quarter gloss set, but notice the change in orientation of the rib. There's an impaction-style fracture there as well.

We want to look at those really carefully but you also want to look at the soft tissues, and one of the soft tissue findings that can indicate the presence of a rib pathology is something called the extrapleural sign. What I am seeing here is, that I am looking at this half of the thorax. Notice the soft tissue that's indenting inward. That is called the extrapleural sign. It is soft tissue outside the pleura pushing the pleura in. One of the terms of this is also colloquially called the cat under the rug appearance. Because if you stick a cat under a rug, it has that same kind of humped-up, heaped-up appearance there. I'd be looking really carefully in that area.

Do not forget if you do have your own radiographic equipment, spot views. The number of times that I have had a patient that had rib pain. focal pinpoint rib tenderness and I did this rib series and it was negative. I would then do a follow-up where I would take paper clips, and I tape them above and below the area of maximal tenderness and I would do spot views. That way the paperclip tells me exactly where to look, It is a fantastic way to put markers on the patient to say, hey, pay attention. This is the area of maximum tenderness.

What about sternal fractures? Sternal fractures do not happen too often. If they do It is usually a direct trauma, driving sports, kind of big for this one. If you are thrown against the seat belt, if you are thrown against the steering wheel, but anything where there is blunt force, trauma to the sternum, and typically, this is going to be a transverse fracture. This is very analogous to a sacral fracture. When we look at that lateral view of the sternum, you can see the cortical offset.

The big thing is if there is sternal pain, dedicated sternal radiographs. Do not rely on a T-spine with an open collimator. You actually have to do a right anterior oblique and lateral to see the sternum most effectively. It is possible to damage the manubiosternal joint, the xiphisternal joint. The big thing is breaking the gladius there in the middle.

Not surprisingly, because this thing moves a lot moves 12 to 20 times a minute. Every time the person breathes, there is a decent frequency of non-union healing for the sternal fractures. An important thing on sternal fractures is to make sure you pay attention to the t-spine very carefully because a sternal fracture can actually increase flexion-extension forces on the thoracic spine, and increase the potential for compression fracture. Pay more attention to the sternum because there's a lot of periosteum involved and It is very painful fracture.

A thing we are worried about any time we deal with patients, who have thoracic cage trauma is what might happen to the organs inside that thoracic cage, and that is what It is there for us to protect them. One of the possibilities, this person's got a bruised lung. There is a traumatically fractured rib. There is some bruising to the lung underneath that area. Other more significant injuries, of course, require higher velocity diaphragmatic injuries, things like that.

One of the concerns is always, did this person, did they damage the lung when they damage the ribs? We will look for a pneumothorax and that's when I am dealing with rib series. It is not uncommon to have a chest and a rib series done to look at the soft tissue component with the chest x-ray, and then look at the bony component with the rib x-ray. One of those concerns is pneumothorax. If I have got somebody who, I do not hear breath sounds as well. Maybe they have got hyper resonance on percussion. So let us definitely look at the chest x-ray and with a concern for pneumo, they have got shortness of breath. Make sure we do inspiration expiration x-rays because pneumothoraxes show up better on expiration views.

Patients with rib trauma, we can also see this in patients with underlying conditions like Marfans and Ehlers-Danlos. Barotrauma is a big one for this one, you get pressure changes in the lung. You can damage some of those more superficial blebs or bullae.

It is not as easy to see on this particular one. I am going to give you a clip, the same view, and then a close-up. The big thing we look for is to indicate the presence of a pneumothorax is to notice that the lung vessel markings go all the way out to within one centimeter of the lung periphery, on this side. But on this side, those vessels are stopping dead. Right there. When we look at the close-up, that's the visceral pleural line. We can actually see the visceral pleura where there's air trapped between the parietal pleura lining the chest cavity and the visceral pleura lining the lung. General rule and we start looking at these. The question is, does this person need a chest tube? It depends on the size of the pneumothorax.

That takes care of us for the spinal trauma lecture. So next up, we are going to continue on with the extremities. Thank you much.

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