

**SPEAKER 1:** All right. Thanks very much to [INAUDIBLE], Chris, and Aaron for the opportunity to speak to you today. Let's see. Which one moves it forward here?

**SPEAKER 2:** The green button.

**SPEAKER 1:** Green button. There we go. All right. So like many of you, this is my practice. I see patients from childhood all the way up octogenarians. And in reflecting on my practice, I've found that at these extremes of age, it can be easier to know what to do for a patient than it is for patients in the middle. And so today, I'll talk to you about considerations for the young adult deformity patient, we'll go through some case examples, common pitfalls, and modes of failure, and then systematically go through causes of pain after adult spine reconstruction.

This is not an adult. This is an 11-year-old who presented with a 50 degree or 45 degree thoracic scoliosis, was recommended to wear a brace and then disappeared. There was loss of follow-up for about a year, and then came back. And her mom says, I think her scoliosis may have gotten a little worse.

And so in this case, very obvious what to do. She gets traction, she gets a fusion and does relatively well because she's young. Conversely, you have a 32-year-old patient with less than half the severity of scoliosis. And whereas the 12-year-old has no pain, this patient comes in with pain, pain, pain. And so what are the causes of pain in the adult the adult deformity patient?

You have the coronal curvature and the disc degeneration facet degeneration that comes along with that. Associated deformities, such as the rib-and-pelvis deformity, eventually sagittal imbalance and coronal decompensation, as well as stenosis. And that was covered very well by Dean earlier.

And that can be central, lateral recess or foraminal stenosis. And stenosis in a deformity patient is different than that of a patient with a disc herniation or other soft tissue causes of stenosis, in that it doesn't tend to wax and wane. It tends to just get worse with time, particularly if it's due to the fractional curve. And then, again, spondylosis from disc and facet degeneration.

And so that brings us to our indications for surgery in the young patient, the young adult patient. Deformity that's painful or progressive or unacceptable to the patient, stenosis that's refractory to non-operative management, and spondylosi causing back pain. Again, that's refractory to non-operative management. And again, in the young adult patient, saggital plane malalignment is less common.

So what do we do? We decompress symptomatic nerves, we stabilize symptomatically degenerative segments and gain a solid arthrodesis. We correct deformity to the extent that we can reduce pain and the excess energy expenditure that's associated with their ADLs, and we operate on segments that need to be addressed to achieve those goals.

And so that brings us to surgical planning. We assess symptomatic regions of the deformity to be addressed, assess how correctable or how flexible the deformity regions are, determine the goals of correction. What do we need to do to make this patient asymptomatic? And formulate a plan based on that. In broad terms, we can think of adult deformities as flexible, rigid, or fixed. And most pediatric deformities, at least the mild and moderate ones, are flexible.

The more severe ones can be rigid. And most adult deformities in turn are rigid. And we typically don't see fixed deformities unless there's a congenital auto fusion or some prior treatment, prior operation. And I would urge everyone to, at the very least, get recumbent films, AP and lateral, to assess flexibility of the spine for your adult patients, if not bending films in and bolster films as well. But this, again, will tell you how flexible each region of the spine is and give you the best possible assessment of how the patient's going to look on the table before incision.

Schwab gave us this anatomic classification of the posterior based releases to destabilize and loosen the spine to allow us to do correction. And this has probably been covered a couple of times today, so I'm s going to go through it extensively. So back to the adolescent population. And we think about-- in thinking about levels to fuse, it's much more established in the adolescent population what parts of the spine need to be fused down to L3 versus L4 for most curves.

And there's good agreement between surgeons on this because we have a good, usable surgical classification. So this is type 5 Lenke curve or Lenke type 5 curve

with a 55 degree lumbar curve and a thoracic curve that bends out to 24 degrees. So it's very clear that we only need to fuse the lumbar curve.

And this is her immediately post op. And then at three months, we see that, as expected, her thoracic curve is reduced a bit to an acceptable point. Fast forward 20 years. Can we apply this to the 37-year-old with the same 55 degree lumbar curve, but now with some secondary degenerative changes?

And as expected, she's presenting with back pain rather than just the concern for progressive deformity. So these are the patients where it's very important to do advanced imaging to look at the lower levels of fractional curve, make sure that it's not advanced disc degeneration or arthritis that's going to prevent the patient from being asymptomatic after surgery if you choose not to go to the pelvis.

And so that's what we did we. Given that her MRI and CT were reassuring, we did a T9 to L4 fusion. Initially, she did well. By three months, her pain was down from a 10 to a 5. And we thought we were kind of out of the woods, but no such luck. As time went on, we see her pain pattern progresses.

Now it's sort of looking more like a Christmas tree and extending down her leg. And so this is a good case example of a patient who kind of falls off the normal kinetics of recovery. And not only is she having more pain, but the pain is now in a different distribution, so that merits further workup. We did a CT scan that showed that she had fused all levels except the lowest level, which explained her leg pain.

So diagnosis is pseudarthrosis at L3-4 and scheduled for a lateral interbody fusion. Hasn't happened yet. But again, a good illustration of the patient falling off the expected recovery kinetics. So that brings us to pain after adult deformity surgery.

We all know that pain in the adult deformity patient is common. Low levels are typically manageable and don't require extensive workup. But when patients are having severe pain or progressive pain, it does necessitate our attention and further workup. And this should include a very careful history of the pain, onset location radiation, and exacerbating factors, a physical exam that's much more detailed than our typical post op exam and is really more like an initial patient physical exam. And then diagnostic studies, including x-rays, cross-sectional imaging, sometimes EMG, and then lab work if infection may be suspected.

Among the many causes of pain after adult deformity surgery, we can sort of conceptualize this into early onset or immediate onset and late onset and then new location versus familiar old location. And this can help us narrow down the likely possibilities for what's causing the pain.

And so, again, going back to the patient. She's a 37-year-old with a lumbar fusion and a pseudarthrosis, so that fits into our chart down here. It's a new location of pain with a delayed onset. So consistent with pseudarthrosis. So this is, to continue the theme, a 35-year-old with [INAUDIBLE] idiopathic scoliosis and debilitating 8 of 10 back pain.

Her flexibility films show that she's more rigid than the last patient. The discs, the lower disc 4, 5 and 5, 1 are intact with minimal degeneration. And the facets are in good shape. So we're planning a fusion that does not extend to the pelvis. We do T3 to L4. And initially, again, she does well. Pain is down to 3 out of 10 by three months.

And then unfortunately, at eight months, she has a fall, presents with back pain radiating to her right groin and anterior thigh. She's worked up for a labral tear, which actually was present but the hip injection only cleared up 30% of that pain. So we looked deeper and we find that she, again, on her follow-up x-rays has evidence of a pseudarthrosis with loosening of her L4 screws.

So she undergoes again a lateral interbody fusion and revision of the lower screws and at this point is doing well. So you think I would learn my lesson after two LIV pseudarthroses, but we'll see. So this is now a 43-year-old with Scheuermann's kyphosis. A little different pathology.

And we're planning to do a T3 to L3 posterior spinal fusion with a stage lumbar interbody fusion. Initially does well. We're satisfied with the correction, and we're planning to do her lumbar interbody fusion at about six weeks post op. Life happens. She misses a couple appointments, and then falls. And again, presents with loosening of her lowest screws and an impending pseudarthrosis, so similar pathology, unfortunately.

But she's treated with a lateral interbody fusion and upsizing of those screws and ends up doing well. So I think take home point, I think this is what I want to stress, is

that patients-- young adult patients really are different physiologically than our adolescent patients. And in particular, I'd urge you to at least consider doing interbody fixation at the lowest disc level. And the question being, how long is too long to get to your interbody fusion?

Apparently, in the last case, two months is too long. And then sort of food for thought. I know a lot of us are sort of all-posterior surgeons. And I think that's fine. But the question is, would a TLF sort of satisfy that interbody fixation that all of these patients needed?

So to get to our last case. It's 52-year-old woman sort of pushing the boundaries of young adulthood who was presenting with 72 degree lumbar curve, 52 degree thoracic curve. Her big problem is her PILL mismatch in addition to the coronal deformity. So she's got a mismatch of over 50 degrees.

This is somewhat rapid progression from April of 2015 to June of 2017. I didn't plot out all of the Cobb measurements, but you can see that she's clearly progressing. And sometimes with these patients, actually, we'll send off muscle biopsies, make sure that there's not a neuromuscular component of why they're progressing like this.

So this is how she's presenting. She has back pain, pain along the right sided lumbar prominence, and then pain extending down both legs from stenosis. Her flexibility films show that she's fairly rigid, as expected. And her CT shows erosive endplate changes as is expected with the advancing of her deformity. Fortunately, she has vacuum discs that we can potentially leverage here.

So surgical options just to open it up to the group. Who would do a thoracolumbar UIV for this case? Who would do an upper thoracic UIV? A few more. Who would do all posterior? A few. Who would do lumbar PSO? Not necessarily.

Anybody to ALIFs? Anybody do laterals? All right. Same folks. OK. So this is what we did. So stage one was an ALIF L5/S1 and laterals from two to five. And so this is her standing sort of inter-stage X-ray. So at this point, who would do a thoracolumbar start UIV? And who would go to upper thoracic? A couple. About even.

Anybody for PSO? No PSOs anymore. OK. So we did all posterior. We were able to

avoid the PSO despite doing Smith Peterson osteotomy, and got her reasonably corrected. I think we're within where we need to be for her PILL mismatch. And she, so far, is doing well. Take home point for this case.

Interbodies increase the power of your correction. One, I think, important point is with the ALIFs-- this is an ALIF design with interfix screws, so screws that go-- that are fixed angle that go into the vertebral body above and below. And by only fixating to either the vertebral body above or below, you maintain your ability to correct over the cage as a fulcrum.

So interbodies increase your power of correction and don't limit further correction. That's something that I sort of didn't really grasp until we did this case. Flexibility films help assess compensatory curves. And still, I think it's worth thinking about limiting your fusion whenever possible to, and trying to do less.

So in summary, don't fuse to the pelvis for the young adult patient, don't fuse to the pelvis unless you have to. But [INAUDIBLE] about the natural history, especially if they have some degenerative changes that have already set in at L4, 5 and 5, 1. Consider interbody above the LIV. And this is something I pretty much have made standard for any of these young adult cases that are not going down to the pelvis. And then also consider interbodies at degenerative discs and as mechanisms of release and deformity correction.

Consider selective fusion of the lumbar spine if the thoracic deformity is stable and well tolerated. And then do a systematic workup of pain after adult deformity surgery. As you know, when you are able to take the time to make the diagnosis, patients do get better and kind of break out of that failed back syndrome place. Thank you.

[APPLAUSE]