

**SPEAKER:** So I'm talking about limited role of doing smaller surgeries and does it work and is it something we should think about? These are my disclosures.

So as we know, patients with adult scoliosis can manage that back pain for many years. But when the spine becomes unbalanced or radiculopathy ensues, that's when patients may seek surgery. But many surgical options exist for spinal deformity.

So when does that pain become unbearable? So we know many, many talks, papers, severe sagittal decompensation, severe coronal decompensation, severe radiculopathy. And usually the scoliosis is often not disabling. It may be painful, but it's not disabling as long as the spine is balanced and there's no radiculopathy.

And this is where a lot of times, as Sig had mentioned, where the pain comes from, is the fractional curve. And how is it painful? Well, as we know, there are basically three types of stenosis. There's central stenosis, lateral recessed stenosis, and foraminal, or up-down stenosis. And you can also get radiculopathy from lateral listhesis, as the bones slide off of one another and begin to stretch the nerves.

The fractional curve radiculopathy may be disabling, and that's potentially what could drive the patient to an operation, even though the scoliosis does not actually disable the patient. And why is this so?

So we look here, if we look at the concavity of the fractional curve, you see the up-down stenosis. You can see how really that foramen is just pinched as it exits. And it's very different from lateral recessed stenosis, which is ligamentous stenosis. It is the weight of the human body. It is the weight of that pedicle pushing down in an up-down manner, instead of a ventral-dorsal manner.

And it also pinches the dorsal root ganglion, so we know that's the most sensitive portion of the nerve. And so patients, as we all know, can chug along for decades with scoliosis. And all of a sudden they say, you know, I can't take it anymore. And it's usually some component-- if it's not a sagittal or coronal decompensation issue, it is the radiculopathy from the fractional curve or from compression of the dorsal root ganglia.

Again, as we all know, laminectomy is usually not effective. You can do a laminectomy until you're blue in the face and you will not alleviate this foraminal stenosis. This stenosis will not respond to a laminectomy. And basically, this will fail and not alleviate that pain, depending on how severe it is.

So we know that painful radiculopathy generally comes from three places, the fractional curve, the major curve concavity, and then lateral listhesis. And as we know, the fractional curve is the minor curve below the major curve at the lumbosacral junction.

And usually, it is L4 to S1. Sometimes it can be L3 to S1. Sometimes it is L5, S1 only. But it is really the change of the Cobb angle from the major to the fractional curve. And you can see here this is where the fractional curve is.

How do you evaluate this fractional curve and whether or not it's actually a source of pain? Again, using the T1 para-sagittal views, looking for the perineural fat, again I think that's really important to look at these views.

And again, if you look at the painful radiculopathy-- here's an example-- you can see how, again, there's concavity. There's lateral listhesis And the two of these can really potentially cause pain.

Here's lateral listhesis. So again, as the foramen narrows and then the vertebral bodies slide off one another, with the lateral listhesis, that could result in the pain.

So the research question we had-- and Sig and I had brainstormed this before we looked at all the data. And this is a compendium of data of all the spine surgeons at UCSF. What if we just fused the fractional curve? And how do the outcomes of just fusing the fractional curve compare with doing the big whack, doing T10 to pelvis, T3 to the pelvis? How does that compare to just doing the fractional curve?

And so Dominic Amara, our medical student who is going into neurosurgery, looked at this and looked at all of our patients for the whole group. And we compared T3 to pelvis, T10 to pelvis, or just the fractional curve.

And as you can see by the artist's illustration, if you do just the fractional curve, you're not going to get as much Cobb angle correction. And the bigger you go, generally you have more power and control of the spine, being able to control the spine and correct the coronal Cobb better.

But again, looking at these outcomes, what were the differences? So we looked at scoliosis patients by eight spine surgeons, both orthopedic and neurosurgery. The fractional curve had to be greater than 10 degrees of coronal magnitude. And it had to have concordance radiculopathy. It couldn't just be back pain or other issues. It had to be radiculopathy on the concavity of that fractional curve.

And so here's what we looked at. And this is our data. The fractional curve at 27 patients, lower thoracic 46 patients, upper thoracic had 26 patients. This is out of nearly 800 patients. And of course, a lot of them were excluded because number one, they didn't have a fractional curve greater than 10 degrees, and they didn't have radiculopathy concordant with that functional curve.

We looked at blood loss, length of stay, spinal pelvic parameters, rate of revision surgery, and then extension surgery-- so how many of those patients who had 4 to 1 needed eventually T10 to the pelvis-- and then complications. This is the data, totaled 99 patients. So the EBL, as you'd expect, was lower in the smaller surgeries. Fractional curve was smaller. Bigger surgeries, bigger blood loss.

The other thing that was very interesting is if you look at first complications, the bigger the surgery you do, the more complications you have. The extension surgery and the non-extension surgery were different. That is to say, if you had T3 in the pelvis, you had a much higher rate of revision surgery for other problems instead of proximal junctional kyphosis or adjacent segment or need to extend it into the cervical spine, wound complications, pseudoarthrosis, et cetera, et cetera.

But if you look at the extension surgery, that is to say if you did a fractional curve surgery, your rate of needing an extension to T10 ultimately was actually a little bit higher.

And again, if you look at this-- and I'll talk about exactly why. But if you look at the PI-LL mismatch, a lot of the patients who had the fractional curve treated only still had a mismatch. So that is to say these patients, we could not correct them as much in terms of the sagittal plane as we could with larger surgeries.

So there were limitations. And this is probably what we think is why we saw a higher rate of extinction, is that there was probably a selection bias. So if you had an elderly patient who is up in their 80s, et cetera, who had health issues, you probably didn't offer them the big operation. You may have offered them a smaller surgery. And they may have come in with more sagittal decompensation, but we didn't address those.

So again, those patients probably had a smaller surgery. And there probably was a selection bias. And that probably is what is discrepant with the data. Patients who were healthy, who had severe sagittal decompensation in the 50s and 60s may have gotten the definitive operation versus an elderly patient.

And I'm just going to talk about a few examples here about what we're talking about. So these are not patients that we recommend for these limited fusions. So again, here's a 50-year-old female. Again, multiple prior fusions, basically sagittally and coronally imbalanced.

This is not a patient who ends up with a smaller surgery. So this patient's severe sagittal/coronal decompensation. She needs the realignment. She needs the definitive operation.

Nor this type of patient. Again, here's a patient Sig and I did together. 51-year-old female, multiple prior surgeries. Again, severe sagittal decompensation. And again, she just needs to be realigned and everything taken back into alignment. And so again, she is not the type of patient we're talking about.

So these are the cases that we're talking about. So here's a 55-year-old female with back and leg pain, prior laminectomy and fusion. And again, same thing. She's got lateral listhesis. She's got a scoliosis. She has loss of lordosis.

Again, her back pain is manageable. But it is now the leg pain that is bothering her. And again, she's had prior laminectomies. All what we did was just address the lateral listhesis and the foraminal stenosis.

And we warned her. We said, eventually you're going to need the longer surgery. But at this point, her pain in the leg is gone. And she has not elected to undergo the bigger operation.

Here's another case. And this is her sagittal view. And again, even though she's still not perfectly balanced, you can see just with some minimally invasive laterals she gets straighter.

Here's another patient example. 70-year-old female who comes to us with right anterior thigh pain. She undergoes two L3 laminectomies. They fail.

She's on high dose narcotics. She can't live with it. Again, you can see scoliosis, concavity, radiculopathy, fractional-- not fractional curve. This would have to be the major curve. Up-down stenosis, lateral listhesis.

That segment basically is the pain generator. If you can identify that one pain generator and get it, potentially you can get rid of a lot of her pain.

Again, she's got the scoliosis. And she has zero back pain. She's got adult scoliosis, 70 years old, zero back pain. She gets a minimally invasive lateral interbody fusion, minimally invasive screws. That's what she looks like. A one level fusion. And again, her pain is completely gone and she's very happy.

So similar thing. It's basically like using a smart bomb or using a carpet bomb. If you can find the pain generator and where that pain is coming from, potentially you can get away with something smaller.

So again, here's another patient. 60-year-old female. Back and leg pain. Again, you can see she's clearly got a scoliosis, clearly has a curve. That's been there for years and years and years, ever since she was young.

But again, if you just get some further imaging and figure out what's going on, you can see what's happening. She has severe, severe lateral listhesis. It almost looks like the two segments are separated there.

And you can see basically at that level where she bends, she's got severe lateral listhesis. We know that's associated with disability. And again, treating this with just a smaller procedure and, again, warning her always that she potentially is going to need the bigger operation. But again, she just has the smaller procedure. And she does not elect to undergo the big whack.

Another patient, 60-year-old female with right-sided leg pain, back pain. And again, very small fractional curve. Very small coronal Cobb angle. Again, just a small procedure to address the functional curve and address the up-down stenosis.

Same here. Same thing. Two decompressions. Still horrible pain. Scoliosis as an adolescent.

Her back pain is not killing her. Very stiff curve. You can see in the bending films it does not move. And again, the MRI shows para-sagittal stenosis from the fractional curve, L4, 5, 5, 1. Two laminectomies failed.

And again, same sort of situation. Just addressing the back, the bottom of the curve, a lift to really induce lordosis in case she does need to go T10 to pelvis to really get a good strong base.

Get as much lordosis at the bottom of the lumbar spine. Get a circumferential fusion, big decompression. And basically, hopefully never revisit that level again.

So again, just going back to the study, this is now accepted for publication into journal *Spine*. Limited fusion we found is associated with a lower complication rate, a lower overall revision surgery rate, shorter hospital stay. However, there is a higher rate of extension surgery compared to the bigger fusions.

So when you counsel your patients, if you're going to do a smaller fusion, it's really important to tell them that this may not be the definitive operation and they may need more surgery. Part of the reason is that there's probably a big selection bias in choosing patients for a smaller surgery. The PI/LL mismatch was higher. And again, the other issue is that with your fractional curve, when you end that fractional curve, you're technically stopping into the major curve of the scoliosis.

So in conclusion, really ask the chief complaint. If it's radiculopathy, claudication, and leg pain, and not really sagittal issues or inability to stand up straight, consider and see if you can find that focal area and think if you can be the smart bomb, not the carpet bomb. Consider smaller surgery if it's really leg pain and not back pain. And again, really they have to be well balanced. You don't want to do this in the patient who sagittally compensated with severe positive SVA, because you're just going to be back doing another operation.

And really, if the complaint is I can't stand up straight, then think about a larger surgery. Look at the sagittal coronal planes, limited fusion if you can identify the cause, if you see severe lateral listhesis or spondylolisthesis. And again, longstanding scoliosis may be painful, but it may not be disabling. Thanks very much.