LUMBAR LAMINECTOMY AND TRANSFORAMINAL LUMBAR INTERBODY FUSION
THOMAS JEFFERSON UNIVERSITY HOSPITAL
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00:00:08
ANNOUNCER: During the next hour in a real-time Internet broadcast, spine specialists at Thomas Jefferson University Hospital will demonstrate a surgical procedure to treat lower back pain. The procedure is called a lumbar laminectomy transforaminal lumbar interbody fusion. Surgeons take bone off the spine to make more room for the spinal canal, free the nerve roots, and then fuse the surrounding vertebrae across the disc space. For many patients, this allows them to return to normal activities and an improved quality of life. You may participate in the program by sending questions at any time; just click the MDirectAccess button on the screen. Physicians may take a post-assessment survey at the end of the program for CME credit.
00:00:55
TODD J. ALBERT, MD: Hello. Good afternoon, I'm Dr. Todd Albert, professor and vice-chairman of orthopedics at Thomas Jefferson University. I'm at the operating room at Thomas Jefferson University right now. We've been operating for approximately an hour. I want to introduce my co-surgeon, Dr. Harrop, associate professor of neurosurgery. He's at the table holding the instrument right now, and two of our spine fellows, Andrew Wight and David Hannala, are assisting as well. I'm in the O.R. as well. I've stepped away from the table so I can introduce the procedure to you. I want to remind all the viewers that you can submit a question at any time during the broadcast by clicking on the MDirectAccess button on your computer screen. We'll try to answer as many of your questions as possible. Today we're performing a lumbar laminectomy for TLIF for spinal stenosis and scoliosis. We're going to be on the air for the next hour, but we've been trying to prepare. It's a very involved operation with multiple steps, and we've been attempting to prepare the operation for you. I'm going to go through the thought process of performing the operation and then give you a few tidbits and pictures of what we do, catching you up to the procedure. While I'm speaking, Dr. Harrop is at the table continuing to operate. We've prepared the patient by exposing them to this point, exposing their spine, which is somewhat involved: taking the muscles off their spine and preparing some sites where we're going to put screws in, which you'll see us do live, and also put a cage in the inner vertebral space. So as you look at your screen, I'm going to go through some pictures for you and a slide talk here, in terms of a laminectomy and TLIF for stenosis and scoliosis, which is what this patient has. So let's talk about the patient first. It's a 67-year-old female who has significant back and leg pain, worse with standing and walking, and it's been refractory to medical therapies. She has the diagnosis called spinal stenosis, which is a narrowing of the spine, and she has degenerative scoliosis. And degenerative scoliosis is a curvature of the spine based on degeneration of the disc space. Here on your screen you will see her x-rays. You can see that her spine is not straight. The dots on the x-ray on your left—it's called an anterior/posterior x-ray. This x-ray is if you're looking at the patient from her back. She is standing with her back to you. You can see the dots. The bottom two dots are L5, the middle two dots are at L4, and the dots above that are at L3. The level straight above that, above the last two set of dots, is L2. We're going to be putting screws there as well. We've already cannulated these pedicles,

making holes in them and markers, which you'll see on the field. We have yet to put in the screws. On the lateral x-ray—which is the x-ray on your right, looking at the patient's side as if she's facing forward; you're standing on the right of her and looking at her—you can see the lines, again, in L3, 4, and 5. You do not see perfect squares at the bottom because of her scoliosis and deformity, so if you imagine a line through the left-sided x-ray, you can see why you see the spine looks overlapped. And this makes a challenge for placing the screws, which we've already confronted. Now, here I've shown you her x—her MRI. You can see on the left pictures, again, what's called the sagittal view—you're looking at the patient from the side—and you can see the bottom level, the bottom disc level, is L5S1. L4-5 above that is severely collapsed, and she has severe stenosis. If you look toward the top of that picture you see the white, which is the canal, is wide open. And at these levels, L3-4 and 4-5, it's very collapsed. To the right of your screen you see what's called an axial view, which is if the patient's laying on her back and we've cut her like a meat slicer and we're looking up from the bottom of the spine. You can see on the right side, if you look at the canal—I don't know if you can see my computer or not—I'm showing you the area of significant stenosis. We then can look at another picture. You can see that it's very tight on your left side—that is L3-4. Again, you're looking at the right side where there's the pinching. And on the right side of the screen there's four cuts. The top left cut looks the most open, but you can see that she has progressive stenosis at each of these levels. So we are left with a patient who cannot walk well because her nerves are pinched. Every time she stands and walks, she has significant pain, worse on the right. And we want to open up her spinal canal, decompress her nerve roots, or open them up, and this is going to require a fusion because of her scoliosis and instability of her spine. So the plan for the operation is exposure, instrumentation, neural decompression, or opening up the nerve roots, and then we do that through a laminectomy, and then a TLIF, which I'm going to go into some detail about what the TLIF is. The TLIF stands for transforaminal lumbar interbody fusion, and that is to prop up the disc space and form a fusion. First let's talk about the diagnosis a little bit. I've already alluded to stenosis being a narrowing of the spinal canal due to disc degeneration and spinal arthritis. So the spine becomes sloppy, the tissues grow into the spinal canal and compress the nerve roots. So there's a lot of squeezing in the nerve roots. You can imagine if someone was grabbing your throat and squeezing and strangling you—this is the effect on the nerve roots. And here is a picture through a spine, a cadaver spine. The lateral recess is what's the area called with the two arrows. That's supposed to be wide open, and that is where the nerve is pinched. And on this patient, her L5 nerve and L4 nerve are particularly pinched on the right side of her spinal canal because of findings much like this, which we see on the MRI. So the symptoms of spinal stenosis are called neurogenic claudication. That means weakness and symptoms when walking, and it has to be differentiated. Physicians who look at these patients have to differentiate neurogenic claudication versus vascular claudication. And in neurogenic claudication, it is squeezing in the nerve roots, not the vessels. But vascular claudication in patients with hardening of the arteries can have very similar symptoms. And so as you see on your screen, pulses are present in patients with spinal stenosis and absent in those with vascular stenosis, or hardening of the arteries in their aorta or their legs. And patients with neurogenic claudication, or spinal stenosis, feel better with sitting and bending over, where vascular claudication will only get better when a patient stops. Similarly, a patient is worse in spinal extension, which occurs when you walk downhill or when a lady wears high heels or when they arch their back. That doesn't help for vascular claudication, and it is worse when they exert themselves. So if they walk uphill or if they ride a bicycle, a patient with vascular claudication, or hardening of the arteries, will have significant symptoms. A patient with spinal stenosis is usually fine sitting and can ride a bike all day. Also very commonly, patients with spinal stenosis say, "I'm better when I'm at the grocery store bending over a shopping cart," so flexing the spine makes them better. Now, the other component of this patient's problem is degenerative scoliosis, and that is a curvature of the spine due to asymmetric narrowing of the disc. And I showed you her x-ray. It looks like a little bit of a "C" from collapse of those disc spaces. Now, axial low back pain, which many patients complain of with back disorders, is not really a surgical diagnosis. Most Americans, 80 to 90%, will suffer episodes of low back pain in their lifetime. It is not—we are not good at fixing this problem with surgery; we do sometimes operate for back pain, but it is rare. The things we can help much better are sciatica, or nerve pinching, much like in this patient. So actual low back pain is usually caused with no sciatica, or nerve compression; disc degeneration only. And again, it's less successful with surgery, as opposed to what we call radicular leg pain, or classic sciatica, due to compression of one or more nerves in the spinal canal. Now, typically acute onset leg pain where a patient has not had leg pain and develops sciatica is due to a disc herniation or very often is due to a disc herniation. This is something that we're the most successful with surgery. With the appropriate diagnosis and failure of nonoperative treatment 95 to 97% of patients improve with surgery for sciatica due to a herniated disc. Now, one might as why we're doing an interbody fusion, or a cage fusion, and it is important to understand a little bit about the biomechanics of this spine. I won't bore you too much with it, but this cartoon exemplifies the forces on the spine wanting to collapse the spine and crush the disc space, collapse it. The normal position of the spine is more with the disc space propped open in what we call lordosis, or a normal sway to the back. So one of the things that we're trying to recreate when we do spinal surgeries and fusions and interbody fusions, and especially in this patient, not only is balance to her spine but appropriate balance. And the presence of an interbody cage, which you will see us place, helps to prop the spine open. So the surgical approach we decide for each patient is dependent on their diagnosis, but the results, the potential complications which we have to go over with the patient that can occur certainly with spinal surgery, and the ability to obtain a solid fusion if a solid fusion is necessary, what we're after, and we do attend to the cost of a procedure in terms of the instruments we use. When we think about doing an interbody fusion, we do it for the following diagnosis that you see on your screen: spondylolisthesis, or a slippage of one vertebrae on another; we do do it for degenerative disc disease, though much less commonly; scoliosis, as in this patient; a pseudoarthrosis is a nonhealed fusion; failed laminectomies; and degeneration above a fusion, or junction degeneration. There is a plethora of approaches available to us: we can do it in the front, opening a patient in the front, called an anterior lumbar interbody fusion, or ALIF; we can do it in the back with what's called a PLIF, or posterior lumbar interbody fusion; or what we're doing today, a TLIF, which is a transforaminal lumbar interbody fusion. And the approaches can be done open, as we're doing today; mini-open; laparoscopically; minimally invasively; a standalone procedure in the front; or partially front-and-back; or completely front-and-back. Today we're going to obtain an anterior and posterior fusion all through the back, but as you look into the wound from the top camera, you'll see it is not minimally invasive. It is not possible to do this procedure minimally invasively and see—get the access and see the nerves in the way that we're going to see them for decompression. There's a number of different types of cages available for the spine and spacers when we take out the disc space to replace it, and I've listed some of those on the left and right. There is a difference between cages and spaces in that cages often are threaded and go in with distraction plugs; spacers are placed more frequently from the front, though we are going to use a type of a spacer put in from the back today. And I've shown you some pictures of the different cages. The cage that just popped up on the right lower area—the carbon fiber cage, similar to what we're going to put in today. And I will show you pictures of that. Now, I'm going to spend a few minutes talking about the TLIF so you understand where we've come till now. And then if Dr. Harrop is prepared, we'll go and do some interaction at the table.

00:13:32

TODD ALBERT, MD: So what is a TLIF? A TLIF is a transforaminal lumber interbody fusion. And here I've shown you a cartoon looking at the back of the spine. This is actually one level lower than we're doing the TLIF at; this is shown at L5S1. The dotted lines you see on the left picture, the dotted lines outline what would be done with a posterior lumbar interbody fusion. And where you see the cutout on the left, that is the approach for the transforaminal lumber interbody fusion. Now, different today is that we're doing a full laminectomy. Because this patient has severe stenosis, we're taking off the middle part of her bone as well. We've done this TLIF approach earlier, and we're going to show you that approach from the side as well on video in a minute. You can see the arrow is the direction of the transforaminal interbody fusion and how we approach doing the discectomy and putting the cage in. What you see here is a cartoon of what's called the dura, or the spinal elements. And the dural tube contains all the nerves in a sac of water, the cerebrospinal fluid, and each of those white lines with the ball on it shows where the nerves go out at each level. The circles are the pedicles, where we're going to put pedicle screws in. And the working zone shows you that is the transforaminal working zone, where we're going to distract and put our cages in. This is an anatomic drawing from a cadaveric model showing you the "NR" is the nerve roots. And again, you can see where the nerve goes out under the pedicle, "P." The "G" is the ganglion; that's the nerve center where nerves come in and go out to your legs and give power to your legs. The blue square you see on the left is the area, again, of the transforaminal working zone. And below, the "P," is the pedicle. That's our marker, that's where we start to do our work above. And you can see on the lateral film the same picture. Now, I'm going to show you some videos of the steps that we've taken to the operation, so if we could run the initial incision video, please. You'll see that video running. Are we running that video? Thank you. Good. And then you'll see what we—how we made a skin incision. And this is called the fascia you see being taken down along the spinous processes. And that's the skin incision. And then we use an instrument called a bovie to take that down. And if you can just run the "Identification of the Anatomy" video now. Thank you. So now the next thing we're going to show you is the identification of the anatomy. After we've done that skin incision and taken down all the soft tissue to bone, here we're pointing out that's the spinous processes and inner spinous ligament. And we're pointing out the facet joint, the facet joint and the—and the lamina. And the area where we're going to perform an osteotomy. And you can see we try to take the soft tissue completely off the bone so we're clear about the bony anatomy. Good, and let's just show the bone—the outline of the bone resection. We're going to run the next video because when we do a TLIF without a wide laminectomy, we have to resect, and this is one of the advantages of the TLIF: we resect a certain amount of bone on one side of the spine. If pathology is only on one side of the spine, many times we can perform that resection as outlined here through what's called the lamina and the pars so that we remove the inferior facet. So there you see some of the things that we've done so far. Now, we use what's called osteotomes, which are bone-cutting instruments, to take down this bone. And we have a series of special instruments, straight and angled, to take down—to take down the bone. And here we're going to run the video to show you that exact resection. This was a former patient of mine where we made this video, and we've cleaned all the soft tissues off. And when the video runs, you're going to see that osteotome—which is the sharp instrument—you're going to see it cutting through the bone and then removing what we call the inferior facet. So we're looking—you're standing looking from the left side of the table to the right side of the table at this patient. And you see with the osteotome I'm cutting and then I'm releasing. And you can see the bleeding that comes from that area as well. So we've removed that facet, and here you're going to see that facet coming off on the next clip after I've released it with the osteotome. I removed that entire facet, and that gives me access to the transforaminal area. And there's—you see what the facet looks like we're holding in the camera. And the cartoon of the view. I'm going to leave it. Can you leave it right there? It's going to keep going. Where you see, I'm looking right at the disc space and the neural elements from a very wide view. Good, thank you. Now, the next thing you have to do—because there's many—you saw the bleeding when I was doing the cut. There's a lot

of bleeding that occurs, and in this next clip, you're going to see us controlling the bleeders. These are called epidural veins, which are around—which are around the dura, or the nerves. And this is called a bipolar cautery that we use. With a little foot pedal, we grab these veins and cauterize them. And when we do so, it releases the dura, or the tube of nerves, so we can move it away and show the—show the disc to ourselves to make a cut in the disc and enter the disc for a discectomy. Now, once we start to do the discectomy—and we've done this already to an extent at the table—we do a discectomy, remove the disc, and then use a series of paddle-type dilators to twist open. In this patient, it's incredibly important to do this because, as you saw from the x-ray, she had a lot of collapse on the right side. So we have to try to open this up to neutralize it, and this will make a challenge to both open it up and to be able to get the cage into the disc space, which we're going to do shortly. And this is going to be a cartoon that runs on your screen, showing the effect of placing these paddle dilators into the disc space. And here you see that you can open it up. And we have a series of sizes where we could open it up to a 12. I would say that this patient on the right side of her spine was as collapses 2 mm. And the effect of spreading that out, of opening it up, does amazing things for the nerve that exits in that area that's been compressed, and worse when the patient is walking. Now, to get all the disc out, we need a series of special instruments called curettes, which are cups, sharp cups, that we scrape along the sides of the m-plates to get the disc material out And here you see these special angles—double and triple angle curettes—because we're going in from one side to reach to the other side. And this will be a cartoon that will run to show you this animation, to show you how these work. If you use just a straight instrument, you can't get as much disc out of the disc space. And so here you'll see the disc—the disc being removed from the side as you look. You can get—with opening from the front, you can get a better discectomy, but you have to go through the morbidity of opening a patient's abdomen. When you open from the back like this, you can reach across with these special instruments and get about 75% of the disc material out, which is plenty to obtain a fusion.
Now, this is another instrument called a chondrotome, a sharp instrument to scrape the m-plate and prepare for—to prepare for the placement of the cage. So we use that. And then I'm going to show you another video of a cage being placed. This is a banana-shaped cage that you're going to see going in after we've cleared the disc space. And you can see the bone—the material inside, which is a sponge and bone marrow, or sometimes bone morphogenic protein, which is not really approved for use in the back, but sometimes we use it as a good bone grab substitute. And here you can see we impact—that's the nerve you see going past the inserter—and we impact it into the disc space. Good, thanks. You can cut that video. So I'd like to go to the table. Jim, are you ready to show some—what you're doing?
00:22:17
JAMES S. HARROP, MD: Absolutely.
00:22:19
TODD J. ALBERT, MD: Okay, good. So what you see—can you go to the overhead camera to show what you—Dr. Harrop has done? Good. Jim, can you give us a tour of where you are here?
00:22:31
JAMES S. HARROP, MD: Here we are. We actually—skipping around a little bit. What we did it—I'll take you down to—this is the—here's the thecal sac here. This is the remainder of the L5 lamina, the L5 pedicle here, and the L5 nerve root coming around the pedicle. This is her side where all her compression was. You can see this is the L4 nerve root coming down. You can see how it's red and swollen. This is the dorsal root ganglion. Here is the collapse of the disc—disc space. Actually, if you guys could get the spreader and we can do a little distraction. And normally what we would do is do the TLIF and do our laminectomy. In order to save a step, we started our laminectomy up at the top. And as you can see, as we distract, it opens up and takes the pressure off this 5 nerve root so it can now freely move

around, whereas before it was completely compressed in the foramen. And we did our—we already did our discectomy here where we're going to put our TLIF.
00:23:36
TODD J. ALBERT, MD: So are you ready to put the cage in, Jim?
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JAMES S. HARROP, MD: I actually am.
00:23:38
TODD J. ALBERT, MD: Well, that's the perfect timing. And you can see what the effect—I was demonstrating by a cartoon, but that live picture is a great picture, Jim, because it demonstrates what you're doing with the—with the nerve root. So we're going to go ahead and spread that open to make it easier. Have you trialed it yet, Jim?
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JAMES S. HARROP, MD: We're actually—we're going to do that right now.
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TODD J. ALBERT, MD: I would start with an 8 trial, Ron, and see if that won't do the trick.
00:24:06
JAMES S. HARROP, MD: Do you have a—let me have that spreader, the 10 spreader.
00:24:12
TODD J. ALBERT, MD: Sometimes if it's very tight we will have to go to a square rectangular cage on one side, depending on what we distract. Is that an 8 to 10 spreader, Jim?
00:24:27
JAMES S. HARROP, MD: This is an 8 to 10 spreader. I'm just trying to give us a little bit more room here. As you can see, she really wants to collapse down.
00:24:36
TODD J. ALBERT, MD: Do you have the Branigans ready? Do you have an 8 Branigan? I think an 8 Branigan. Jim, they're going to have an 8 Branigan ready for you. If you need it, just put in on one side. We may end up getting—need to get that, a Branigan cage. The other thing to note as you're watching this, for the audience, is when patients get collapsed on one side like this, their bone—even though this patient's bone quality isn't terrific, the bone gets very, very hard and sclerotic, whereby we actually can put a lot of force on it, whereas in an osteoporotic patient, we often cannot.
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JAMES S. HARROP, MD: I don't know if you can see. Actually we can see all the way down into the disc space.
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TODD J. ALBERT, MD: You get the sense, Jim, at the lower part right below the spreader where the metal instrument is, the big hole.
00:25:29
JAMES S. HARROP, MD: Here's the back of the dura right here, and then we're way ahead of it in here. And we took out all the disc all the way onto the other side.
00:25:37
TODD J. ALBERT, MD: Do you have that 8 trial?
00:25:45
JAMES S. HARROP, MD: Do you have a mallet?
00:25:56
TODD J. ALBERT, MD: Does it look like that 8's going to fit?
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JAMES S. HARROP, MD: Actually, it's all right.
00:25:58
TODD J. ALBERT, MD: Okay, great. I would keep that distraction up, and then why don't you load an 8 with the material, Ron? Oh, I forgot that our most—one of our most important critical member I forgot to introduce was Ron Forcina, our scrub nurse who's helping. He's critical. Without him we couldn't do the operation. He's the only one who knows the names

of the instruments. So Ron's preparing putting some bone graft material—or bone-making material into the cage that he's loading that Jim is going to then put into the interspace. He's already prepared the m-plates. Jim, I think maybe after we do that we should probably—we've already prepared the screw holes, so maybe we should put the screws in.
00:26:46
JAMES S. HARROP, MD: Okay.
00:26:49
TODD J. ALBERT, MD: And our monitoring p—we have monitoring people in the room. They're a critical portion—part of our team as well. Craig Matsumoto, who will help us monitor the pedicle screws. That helps us be safe in terms of if the pedicle screw—to make sure the pedicle screw is in the bone. Jim's putting the cage in now. It's almost a two-step process. He's putting—you can see the angle of his hand. So he loads it in and then he tries to put it as ant—as anterior, or toward the front of the disc space, as possible because if you remember that cartoon I showed at the beginning of the talk, that helps us prop open the disc space to keep the patient in what we call lordosis, or sway. This patient has lost some of her lordosis from the deformity. Maybe you want to increase one click on that, David, the distractor, so he can put an anterior. Can you give a little more squeeze, or it's not going to go?
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DAVID HANNALA, MD: That's pretty inferior.
00:27:56
JAMES S. HARROP, MD: Okay, good. Great.
00:27:57
TODD J. ALBERT, MD: Great. Great. So do you think the next stage, Jim, should we go ahead and put the screws in?
00:28:05
JAMES S. HARROP, MD: Let's show what happens when we take the distraction now off.
00:28:10
TODD J. ALBERT, MD: See how it collapses but not as much as b—he still has room. You can see how the nerve—give him a Murphy probe to demonstrate the space for the nerve.
00:28:19
JAMES S. HARROP, MD: You can see now the nerve's back in a normal position right in the middle of the foramen. It's completely free, looks very relaxed.
00:28:31
TODD J. ALBERT, MD: Jim, we have a couple questions. Do you mind if I answer them while you go ahead and start putting the screws in or whatever you're going to do next?
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JAMES S. HARROP, MD: Sure, I was exactly going to do the lami, and then we'll do the lami and then we'll put all the screws in.
00:28:40
TODD J. ALBERT, MD: Perfect. We're at about 29 minutes now, so we're in pretty good shape. I have a question from the viewing audience saying, Will we be using the patient's hip bone for the fusion? And the answer to that is in this case we will not, which is an advantage for the patient. It's our number one complaint from patients when we take bone grafts, so we've gone for other materials and means for avoiding fusion. In this patient, since we're doing this laminectomy over two to three spinal levels, we'll save the bone from the laminectomy. In addition, we're using a material called bone morphogenic protein. Now, I should spend a moment speaking about bone morphogenic protein. It is a molecule. It's been a great advance in spinal surgery. It's a molecule made from recombinant DNA that is a precursor molecule to making bone. It derives the cells, it brings the cells from the tissues and the blood to the area of the fusion and creates bone. It's very effective. However, the FDA has approved it for use in anterior spacers, so technically this is an off-label use. However, it is in an anterior spacer, but it's put it from the back. So it is a surgeon's

discretion to use it; however, this is an off-label use of the bone morphogenic protein we're using. We mix it with the bone, and we've been very happy with the fusion. Sometimes in a small percentage of patients, because it's put in posteriorly, it can create an inflammatory reaction where they do get some leg pain. It usually responds to steroids, and it's always self-limited, but it can be painful for the patient. So the answer to that question was a long answer, but we won't be using the patient's hip bone; we'll be using her loc—what's called local bone and bone morphogenic protein. I was also asked, Could I please elaborate on spinal spacers, such as X-Stop, how it could ultimately reduce the need for a laminectomy procedure; any thoughts on the efficacy of X-Stop? Okay. This is—X-Stop is under the broad category of spinal bumpers, and spinal bumpers are meant, as I explained to you, that spinal stenosis patients get relief of their symptoms from bending forward and their symptoms get much worse with spinal extension. So the idea of the X-Stop is to block spinal extension. And there's other devices like this where they're put between the spinous processes. What they're been show to be useful in is mild spinal stenosis. This spinal stenosis, in at least my opinion, is more severe than could be helped with an X-Stop. They've been helped in mild to moderate stenosis, and the advantage of these things, I think they are an advance in spinal surgery, the advantage is it's much less of an operation. The operation you're seeing here is a major operation: it has a blood loss associated with it, it has a large dissection. The X-Stop-type procedure can be done as an outpatient in the appropriate patient, and they go home the same day, much like a discectomy is done in the younger patients. So they are an advance. I don't think it would be appropriate for the patient given the degree of deformity she has and the degree of stenosis, but there is a place for them, and I think you're going to see more of those type of procedures. Okay, we'll go back now to the overhead camera. Jim, looks like we've got a nice laminectomy and you're feeling throughout the—what's called the lateral recess, correct?
00:32:22
JAMES S. HARROP, MD: Correct. We're cleaning out the nerve roots on the right hand side.
00:32:29
TODD J. ALBERT, MD: And Jim, can you talk about how when we put in the screws we're going to do a slight distraction. We're going to do a slight distraction across where the concavity is. If we go back—I'm going to go back to the x-ray so we can be looking at the x-rays on her on the PowerPoint.
00:32:48
JAMES S. HARROP, MD: Once again, with—this lady has a deformity in multiple planes, and what we're going to try to do is try to help balance her out. And how we're going to do it is you have to remember that the nerves go through the foramen, and when we have a scoliosis, which causes compression on the nerve roots, just like we did with the TLIF, we lift it up on one side. How we're going to try to do that as we go up is we're going to distract. But a little distraction, or make the space between the pedicles a little greater, giving the nerves a little bit more room with the overall thought of trying to make everything lined up.
00:33:26
TODD J. ALBERT, MD: Correct. And we get a secondary—we get a secondary effect. If we look on the x-ray, if you look at this between the second and third dot up on the left side of the left picture, you can imagine that if we do a slight, slight distraction there, we're going to open up the area where that nerve exits. So Dr. Harrop will help take away the bone that's pressing on it and the soft tissue, but we'll also get some additional opening of that hole through a slight distraction. Now, there is a negative that comes along with distraction. If you remember earlier, I said we want to restore the patient's normal sway to their back. And when you put a distraction force, or an opening force, on the back of the spine, you can flatten the spine out. So we have to be oh-so-careful both in our positioning and how much distraction. In this patient, at most a millimeter, or one click on that distractor you saw, will help with a—will help with opening the nerve root if necessary. Dr. Harrop's doing a superb

decompression here, so it may not be necessary. The other thing I should talk about when we talk about patients with degenerative scoliosis is our goal is not to correct her deformity, as it is in an adolescent patient with scoliosis where we try to correct the deformity significantly. The goal here is because we have to do the decompression to free her nerve root, is to prevent her from getting worse. I get the questions all the time from patients, "Why do you have to do a fusion? Can't I just have a laminectomy?" It would be a disaster to do a laminectomy alone in this patient because you would destabilize her, and that deformity would get rapidly worse, leading to a significant increase in back pain and probably, even if she had a honeymoon period where she got resolution of the nerve pain and the spinal stenosis, it would certainly come back from the high degree of instability. And we see patients like this and it becomes much, much harder and more difficult and dangerous operation to revise that. And it turns into an anterior and posterior—front and back—fusion much more frequently. So it's our strong recommendation. In this case, this is the conservative, not the aggressive, thing to do. The very aggressive, foolhardy thing would be to do just the laminectomy. So let's go back now to the operation and see where we are with our laminectomy. Can we go to the overhead camera, please?
00:35:48
JAMES S. HARROP, MD: Kind of hard a little bit to see because I actually am undercutting.
00:35:52
TODD J. ALBERT, MD: Now, we can see the direction, though, Jim, of—that's called a Kerrison instru—that's called a Kerrison rongeur, and that rongeur is a biting instrument to undercut the bone, so.
00:36:05
JAMES S. HARROP, MD: We're almost done with the laminectomy. And what I did is I individually found each nerve root and then followed it out along its course to make sure it's not compressed.
00:36:13
TODD J. ALBERT, MD: Jim, we've got some very good questions. These sound like perhaps patient questions that I think would be very helpful to answer. The first question I'm going to answer, or put out to you to answer: "What is the benefit of putting the bone graft in the disc space?" The advantage of putting the bone graft and the spacer in the disc spaces, too. The spacer is to prop open the disc space and keep it neutralized to correct the deformity, but the bone graft, the fusion—the rate of fusion is much higher when we put the bone graft in the disc space, as well as in the back. And you're going to see we're going to put bone graft along the back as well, which we'll show you as Dr. Harrop starts to put the screws in the holes we've made, we'll see the area where we're going to put the bone grafts as well. But the answer is the benefit is increased fusion rate, and it's very good in that area. It's a great milieu for fusion healing. And another patient asked, "Can I be treated without surgery?" It totally—the answer is it totally depends on what you have. Most things in spinal surgery, other than spinal cord compression in the neck or in the thoracic spine, most pinched nerves in the lumbar spine are operated on for pain and disability, for a patient's loss of function, not for severe weakness. Though we do operate—there are times we operate for—emergently if patients lose their bowel or bladder, and I guess it's important for our watching audience to know that is one true emergency in lumbar surgery: it's called cauda equina syndrome, if they lose control of their bowel and bladder from severe compression of the nerves. It's rare, but if it happens we have to try to operate on patients within six hours. It's not always possible because they don't always make it to the hospital in that time. So there are emergencies, but the answer is patients don't have to be treated with surgery. But most patients cannot continue to live: they can't walk, they can't tolerate the pain, despite having tried multiple nonoperative things—injections, physical therapy. And we always try that first on a patient before suggesting surgery. But most of the patients that we end up operating on have had a full course of nonoperative treatment. So the answer is you can be treated without surgery, but many patients who get surgery can't live

and choose to have it. It's not exactly cosmetic surgery, but it is in a way elective. And finally, how long—this is a good, practical question—how long does the patient have to wear a brace? We typically brace patients after this operation for six weeks. We hope to fix her well enough to brace her to restrict her activity a little bit. She'll only wear a brace when she's out of bed—and she'll get out of bed starting tomorrow. We'll brace her for six weeks. At six weeks, she'll come for her follow-up, she'll have x-rays. She'll get the brace—start weaning out of the brace over the next week to two weeks after that visit and begin physical therapy. And usually, I tell patients, after an operation like this by about six weeks they're going to be feeling pretty good if they walk a lot at home and do kind of try to stay as active as possible. That's why we fixed her, so she can get up and get going, and that'll help with her muscle pain. And then we will get them doing therapy and get back to normal almost within three months.
00:39:30
JAMES S. HARROP, MD: Todd, we're going to go ahead with putting the screws in now.
00:39:32
TODD ALBERT, MD: Okay, it's a perfect time to demonstrate. We've answered the last question.
00:39:36
JAMES S. HARROP, MD: So I need a probe first.
00:39:39
TODD ALBERT, MD: So what you're looking at now—you're looking at the beautiful decompression he did in the middle. That's the sac of nerves. And these are the screws you're looking at. Ron is going to load up the screws for us. And we're going to use all sixes.
00:39:53
JAMES S. HARROP, MD: You might want to show them these transverse processes here.
00:39:58
TODD ALBERT, MD: And you're going to burr them and put some bone—Ron's going to mix some of the local bone with—make fajitas, Ron? And you've got some local bone, right?
00:40:09
JAMES S. HARROP, MD: Do you have a joystick?
00:40:13
TODD ALBERT, MD: So Dr. Harrop is now going to put this—this probe down the hole where the pedicle hole was made previously, where we made the hole, and he's putting it down to feel it and feel the depth. Dr. Harrop, you're very good at doing those pedicle holes.
00:40:30
JAMES S. HARROP, MD: You know, it's a lot of practice.
00:40:34
TODD ALBERT, MD: Okay, so he's going to put that joy—that's called the joystick that we probe the pedicle with. And then we've done that already before the start because you can imagine if we started this operation at noon, we wouldn't even be done really with fully exposing, so we wouldn't have been able to show you all the parts of the operation. That's a 6mm by 40mm—that's 6mm-diameter by 40mm. It's got a nice, sharp enough point that it will go down. You see it going down the pedicle right next to the nerve. So you can imagine the nerve. What level is that at, Jim?
00:41:08
JAMES S. HARROP, MD: It's at L4.
00:41:09
TODD ALBERT, MD: Okay. So the L4 nerve root goes right medial to that. And after we put the screws in, we're going to do something called triggered EMG, where we're going to put a little probe down on the screw and put an electrical current through it. Craig's going to then ramp up the current and read if they get what's called an electrical breech, or at what point they get an electrical impulse through a catch to leads in the patient's lower extremities at different muscles enervated by L4. And depending on what we call the threshold, the

amount of voltage that we read in the lower extremity, we will know that the screw is okay and not breaching the pedicle.
00:41:53
JAMES S. HARROP, MD: Might want to also add that we did check x-rays before to make sure everything looked fine.
00:41:57
TODD ALBERT, MD: Yes, we put in some markers—thanks, Jim—we put in some markers before the webcast started and took some x-rays to insure that we're in the right area in the pedicle. Now, it's challenging because of the patient's scoliosis to know for sure, but that's why the EMG helps. So here you can see them placing the screws as well.
00:42:18
JAMES S. HARROP, MD: And I don't know if you can see this or not, Todd, with the camera, but you can see she's got very thin dura. You can actually see the nerve roots, and here's the filum, actually, right here with her nerve roots underneath in the thecal sac.
00:42:29
TODD ALBERT, MD: Yeah, that's actually a good picture. Somebody's head's in the way now.
00:42:31
JAMES S. HARROP, MD: Sorry, that's probably mine.
00:42:35
TODD ALBERT, MD: But what Jim is showing you is the sac of nerves. Can you go back to that? He's pushing around the nerves. That sac is filled with water. I'm sure everyone in our listening audience has heard—or watching audience has heard—about cerebrospinal fluid. Cerebrospinal fluid is inside it, and he's pushing the nerves back and forth. It's okay to do here. If we were in the cervical spinal cord, we cannot touch it because we can paralyze the patient. There's a buffer around these nerves to allow us to do it. Now they're going to measure the rod and cut it and contour it. And Jim, I would make it a little longer on the left side just for the most slight distraction between maybe 3 and 4. You probably want to check those real quick, also, those—So maybe you want to just cut drill, and Craig will just give us a thumbs up; you don't have to scream it out. And when we test these, you'll see they stick a needle in the skin. We have to do a ground to make a full circle.
00:43:36
ASSISTANT: How do these heights look to you?
00:43:42
JAMES S. HARROP, MD: I need a rod bender.
00:43:45
ASSISTANT: How do these heights look to you?
00:43:48
JAMES S. HARROP, MD: Looks pretty good.
00:43:52
TODD ALBERT, MD: Andrew, can you go ahead and test those screws before he puts the rod in?
00:43:54
ANDREW WIGHT, MD: Sure.
00:44:03
JAMES S. HARROP, MD: Craig, you ready?
00:44:05
CRAIG: Yeah, we're ready.
00:44:06
ASSISTANT: L2 on the left.
00:44:08
JAMES S. HARROP, MD: The head turner.
00:44:18

ASSISTANT: L3 on the left. Just give him the thumbs up if you want.
00:44:29
JAMES S. HARROP, MD: I need a large rongeur, please.
00:44:30
TODD ALBERT, MD: And there you see the probe inside the hub of the screw and they're ramping up the electricity. Okay, we're good?
00:44:38
ASSISTANT: Next one's L4 on the left. Next one's L5 on the left. Okay.
00:45:03
TODD ALBERT, MD: Good. So our left side is all good, Craig?
00:45:06
CRAIG: Yeah.
00:45:08
TODD ALBERT, MD: Good. I would like everyone in the listening audience to keep their fingers crossed while we do the right side.
00:45:12
ASSISTANT: Right L2.
00:45:16
JAMES S. HARROP, MD: Can I get another rod there, Ron? One more time.
00:45:29
TODD ALBERT, MD: Jim, after we test the screws, would you mind—we'll go in and show where the transverse processes on the other side are and where we put the bone graft? And then I'll spend a few minutes why we do an anterior-posterior, what the comparison are, the advantages, before we close and take any other questions.
00:45:55
JAMES S. HARROP, MD: Can I get a coca, please?
00:46:01
ASSISTANT: Right L5.
00:46:06
JAMES S. HARROP, MD: You can see if my rod is—that other rod might be a little too short, but we'll check it out. Might have to make it a little longer. Yeah, I think I want your side a little longer.
00:46:21
TODD ALBERT, MD: Okay, we're good. So all our screws are okay, so now what we're going to show is our—the rod being placed into the screws. These screws are called polyaxial screws, so they allow us top-loading and they allow us to place the rod through the top. We bent it appropriately to make, not only—we compromised between how it fits into the screws and the way we want the screws to look and then we tightened these screws and tighten the rod down so that it will be all connected. And this makes the spine very stable. When you get to that left side, before you tighten the 3 and 4 screw, we're going to take a distractor to—
00:47:02
ASSISTANT: Can I use this—just the length? Screwdriver?
00:47:06
TODD ALBERT, MD: Jim, when you get those caps on—are you on the left side now, Jim?
00:47:09
JAMES S. HARROP, MD: We finished the right side.
00:47:12
TODD ALBERT, MD: Okay. Before you do the left, why don't you—when you drop that rod in and you get the caps in 3 and 4, let's do a minimal distraction between 3 and 4 because I think it will really neutralize her out really nicely. And also, if you could show the audience either on the left or right side, whatever's easier with keeping your head out of the way, to show where the transverse processes are where the posterior-lateral fusion's going to be.

00:47:36
JAMES S. HARROP, MD: I don't know if you can see it or not, but it's right here. Can you guys just back out so he can get a little light in here for a second. You can see here's the transverse process between the bones.
00:47:45
TODD ALBERT, MD: We can't see so well where you're pointing out.
00:47:48
JAMES S. HARROP, MD: Oh, I'm sorry. See if this helps you. The transverse processes—
00:47:54
TODD ALBERT, MD: Okay, where he's—there you can see it. So you see, just to the side of the screw that's where the transverse process is, which is like the wings of the spine. And so what we're going to do is we're going to unstrip the bone at the top of that and then lay some bone graft—both the bone we've taken out of the patient mixed with some more bone morphogenic protein that's leftover from what we used in that cage, and we're going to put it along the side to heal the fusion and, like, weld the spine together. So while they're hooking up the spine, let me go through a couple slides. We have about 12 minutes left, so I would encourage you if you have any other questions to put them in before we go off air. This is just some data, and important, when people say, "Why do you not do the front and the back fusion and just do this TLIF?" Well, if the indication is correct for a TLIF, the TLIF in this paper, done by Hee and Castro, showed—looking and comparing 53 patients with anterior-posterior fusions to 11 patients done with a TLIF, they showed shorter O.R. time and hospital stay. Think about it. If we did a front and a back fusion, we have to go all the way through the front of the spine and then through the back – two operations—so O.R. time was less, hospital time was shorter for patients with a TLIF, and the blood loss was less. In addition, having lower complication rates and lower arthrosis, or non-healing rates for the TLIF. So both of them—both of the groups did have some issues with persistent radiculopathy. I've received another question: "What have you experienced as your largest inconvenience or limitation, in terms of surgical instrumentation or devices for spinal surgery?"
00:49:42
JAMES S. HARROP, MD: Do you have a distractor? I'm not answering that.
00:49:47
TODD ALBERT, MD: Are you not answering that because there's never been—there's been no limitation, we're not limited in what we have?
00:49:54
JAMES S. HARROP, MD: No, because I'm trying to be political for the first time in my life.
00:49:56
TODD ALBERT, MD: Okay, it's unlike you but I'll try… The limitations at this point, I think, are in terms of sometimes what we say when a patient has a severe deformity—not this deformity, which is not considered severe—but when a patient has a severe deformity, linking the instrumentation. We can—we can hook it up, we always can get it done, but sometimes it's much harder than others. So if you noticed, they're doing a very slight distraction between the screws, very slight—that's going to be a millimeter—just to get it slightly open at that foramen. Perfect. Right there, right there. And now they'll tighten it down and he'll—don't pop off, just loosen it lightly, David. That's going to be—that's going to make a difference. Jim, take a Murphy probe and put it in that—and put it in that foramen. That little amount. It slid a little; I don't think it slid back all the way, though. Can you—is it wide open now?
00:50:52
ASSISTANT: Yeah, it feels good.
00:50:54
TODD ALBERT, MD: Yeah, that makes a big difference for that exiting nerve root. And you'll see there's going to be a final tightening that's going to happen. You can hear that squeak?

I don't know if the audience can hear it through Jim's microphone. That squeak is titanium; that's the sound titanium makes when you're tightening it against distraction. This is called the final tightener. It's two parts to it. You can see there's a counter-torque piece while we twist it—and you hear the snap, it only has to snap once because that means it's tight enough. It has a tightening torque to know that it's tightened enough. Well, here's a good question, Jim: "I have been recommended to have"—not me, Todd, but this patient who wrote this question in—"I have been recommended to have this procedure. Is this the latest and best procedure or is there something new on the horizon? I have to say, to answer that question that it really depends on what the diagnosis is. We—there are many choices, in terms of spinal procedures. There—as I said at the beginning of the talk, there's minimally invasive, maximally invasive, and front-and-back versus back alone. And it has to be—I would say that your surgeon has to be comfortable with multiple approaches to fit the approach best to what your diagnosis is. We think for this particular pathology and problem that—which is not a simple problem—this is the best and I guess latest procedure. Some might argue that they could do it minimally invasively through little puncture holes, but I would say we have finished this procedure in approximately 2 ½ to maximum 3 hours. Were that operation done through tubes would take 6 to 7 hours, and there's negatives associated with that. But it really—to answer that question, it totally depends on what your exact pathology is, so I would recommend talking to your surgeon and say, What are the alternatives? Are there any other ways this can be done? And why they think, if they're recommending this, why they think it's the best procedure.
00:53:10
JAMES S. HARROP, MD: We're going to decorticate.
00:53:11
TODD ALBERT, MD: Okay, great. Why don't we—you're going to do it with a T-handle? So if you look down into the wound now, this is a T-handle that Jim is grabbing, and this is an instrument so that we can take the flap of muscle and pull it up to get it away from where we've—where the screws are and to be able to look directly at the transverse processes so that the high-speed burr that they're using is unseating the bone from the top of the transverse process, or what's called decortication. Our goal here is to make the bone in the patient think—the patient's body think that they're had a spine fracture, they're had a bone fracture, because the process of bone fusion is the exact analogous process to healing of a fracture, where cells will come into the area, blood cells, basic blood cells, and they will be bone-forming cells. But we are going to help them along with putting the patient's own bone, wrapped with some bone morphogenic protein, which is another material that helps bring those cells there, and then when we follow the patient—I should make mention of how we follow the patient—We'll see this patient at six weeks—we'll watch them in the hospital, then we'll see him at six weeks after surgery, sooner if there's an issue that we need to take care of, but usually six weeks after surgery, three months after surgery, six months after surgery, a year after surgery, and then yearly after that. They're our patients for the rest of their lives because when you have a spine operation, you have multiple levels in your spine and we have to keep an eye on the other levels. And generally, patients can do great. 80% to 90% of patients do great throughout their lives, but it's best that—and very important—that they keep, in terms of good spine health, that they keep in superb condition and keep their back muscles in great condition. You can imagine looking at that wound and what we've done to that patient's muscles. It's going to be very important to rehabilitate her muscles and get her active again, and which many patients will do. This patient is very thin, healthy, and she will get very active again, I think, and be less inhibited than she was previously. I think we'll just finish up the last few things to say that we're not the first ones doing this procedure. You see on your screen a report by Dr. Lowe in 2002 showing good results with a TLIF, and this is just to show you that this is the cage we put in the patient. This is for another indication. This is one of my other patients that we've done it for called an isthmus spondylolisthesis, and you can see at the lowest level how narrow their disc

space is. And on the right picture, there's a cage in there. These cages are what we call radiolucent, where you can see right through them. So we can watch the bone heal. They have little dots, and here are—you can see a picture, again, with that arrow. So I guess I want to thank everybody who's participated. Jim, you're decorticating a little more?
00:56:20
JAMES S. HARROP, MD: Yeah, we're doing the other side.
00:56:23
TODD ALBERT, MD: I want to thank the Jefferson media marketing group that's put this—helped us put this webcast together. I want to thank our patron, who will remain anonymous, for allowing us to do the webcast, and all the people who helped with the surgery: our spine fellows and all the media crew that was here. They did a great job without interrupting our surgery at all or our setup for the surgery, allowing us to bring it to you. I hope you've enjoyed spending this hour with us and maybe learned something about spine surgery. I guess the thing to fin—the final thoughts about spinal surgery: it can be incredibly effective, but it's also super important that patients who have spine surgery have it for the appropriate indications and the right type of surgery matched to their indications. And we think we've done this for this patient. We have had no problems during the surgery. Our monitoring has been good, so we know her nerves have been good. Her decompression looks great. So we think we've achieved her goals that we set out for her, and we hope she'll do terrific afterwards. Part of it will depend on the patient as well. So if you have any further questions, certainly please don't hesitate to call 1-800-JEFF-NOW. We're happy to help, both the neurosurgical and orthopedic department works closely together on spinal problems and we're happy to see any patient with these type of problems who's been recommended for surgery. Jim, is there anything else you want to point out before we have to sign off here?
00:57:57
JAMES S. HARROP, MD: No, just once again we're going to check all the nerves, and they look great.
00:58:00
TODD ALBERT, MD: Do you want to give people a final tour of what you have there?
00:58:03
JAMES S. HARROP, MD: Okay, so here we are up at the top.
00:58:04
TODD ALBERT, MD: Can we go to the overhead?
00:58:06
JAMES S. HARROP, MD: This is L2, L3, L4 and L5. You can see the pedicle screws go down the pedicles, which are right here. I don't know if you can see it or not. Watch my [inaudible]. Go around them. These are the nerve roots—the L5 nerve root. And here we really exposed the L4 nerve root. And in between the retrieval bodies are our disc spaces—we talked about those. With our cage in here.
00:58:34
TODD ALBERT, MD: Jim, can you retract the dura at all to see the cage? Put your sucker on it? That looks great, Jim.
00:58:46
JAMES S. HARROP, MD: You can't really see it. The light's not great. But we did get it—we did get it pretty far anteriorly.
00:58:52
TODD ALBERT, MD: Great. I think that's what we wanted. I think your x-ray's going to look terrific. We should call for x-ray, actually.
00:58:59
JAMES S. HARROP, MD: And then what we did do is we did save a lot of the bone on this side, and I undercut significantly to find all the nerve roots way out.
00:59:06

TODD ALBERT, MD: Great. And that's her left side, which was not as symptomatic as her right side. You know, it's interesting. You can look at her dura sac and see that it's straighter than what the picture was before because you've corrected her deformity to an extent at 3-4 and 4-5, which is terrific. I need to do some goodbyes here. Jim, thank you very much. That's terrific. So I want to remind CME viewers that they can receive CME credit by completing their evaluation at the end of the broadcast. You can also make an appointment or refer a patient by clicking on the appropriate button, also on your computer screen. You can also—you can replay this webcast anytime. It's going to be embedded starting tomorrow, I believe, November 16. It will be available at www.jeffersonhospital.org/webcast. And that's starting tomorrow. I know my mother's going to be watching it a lot. So thank you all. I'm going to wrap up. Thank you all for watching and thank you for everybody who participated today. Good day. Have a good day.
01:00:23
ANNOUNCER: This has been a real-time broadcast of a lumbar laminectomy and transforaminal lumbar interbody fusion from Thomas Jefferson University Hospital in Philadelphia. To make an appointment with a Thomas Jefferson University Hospital physician, call 1-800-JEFF-NOW or click the "Make an appointment" button on the screen. Physicians may take a post-assessment survey at the end of the program for CME credit. This Internet broadcast represents the hospital's ongoing efforts to bring the latest medical education to both patients and the healthcare community.
01:01:05
[END OF BROADCAST]