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That's today's presentation with the following distinguished faculty from The Ohio State University Wexner Medical Center and Arthur G James Cancer Hospital, and Solove Research Institute. And now filling in for our moderator, Dr. Jim Allen.

>> The evolution of spine surgery in the past 60 years is epitomized by two Americans.

President John F Kennedy and NFL quarterback Peyton Manning John Kennedy injured his back playing football in college. His spine disorder was so severe that he was rejected from the military twice before finally getting an appointment in the Naval Reserves as a PT boat officer during World War II.

After the war, he underwent four spine surgeries, all of which were unsuccessful, leaving him with debilitating pain and requiring him to use a back brace as president. In November 1963, he was shot twice while traveling in a motorcade in Dallas. The first bullet resulted in a non fatal injury that should have caused him to fall forward.

However, his back brace prevented this with the result that he was still upright when the second bullet struck, killing him. In this sense, his failed back surgeries contributed to his death. But now let's move ahead to 2011. Peyton Manning had just completed his 13th season with the Indianapolis Colts starting every single game and winning four NFL, most valuable player awards as well as winning a Super Bowl Championship.

But years of football I left him with spinal stenosis and a herniated disc. So in May 2011, he had spinal surgery, but afterwards he was only able to throw football for about five yards. He underwent a series of three additional spine surgeries they caused him to sit out of the 2011 football season.

The Colts released him in March 2012, and it seemed that his spine disorder was going to cause the end of his career. However, the Denver Broncos took a chance on him and signed up for the 2012 season. Manning threw seven touchdown passes, becoming the first player in 44 years to do so that that first game.

That year, he took Denver all the way to the Super Bowl and was awarded his fifth MVP award. In 2014, he became the NFL leader in all-time passing touchdowns, and then in 2015, he took Denver to the Super Bowl again, and this time won. The advances in surgical technique between 1957, when John Kennedy had his fourth spine surgery, and 2011 when Peyton Manning had his fourth spine surgery are truly amazing.

Today on MedNet, we're gonna show you just how far spine surgery has come. Joining me in the studio is Assistant Professor of Neurological Surgery and the residency program director in the Department of Neurosurgery, Dr. Andrew Grossbach. Andy, welcome.

>> Thank you, Jim, thanks for having me.

>> Well, Andy, back pain is incredibly common in primary care practice and managing back pain often requires a lot of different specialties.

How is the OSU Spine Care program organized and what are its main components?

>> So the Spine Care at Ohio State is really a multimodality system, so we know that, most patients with back problems with spine problems, don't go on to end up needing surgery. So our spine center Ohio State not only incorporates neurosurgeons and orthopedic spine surgeons, but also physical medicine rehab, anesthesia pain.

And so we really try to take a multimodality approach to treat these patients, non-operatively if possible, and then having, surgery options for when those treatment options fail.

>> Spinal stenosis and lumbar disc herniation are two of the most common spine conditions that are seen in primary care. Do all patients with stenosis or disc herniation require surgery?

>> Definitely not, most patients with spinal stenosis or spine problems don't end up needing surgery. And that's why I think it's important to have this multimodality care where we start with the more conservative things. Things like physical therapy, targeted spine injections, and really reserve surgical options for the patients that don't get enough benefit from those other treatment options.

>> Well, thanks Andy. For all of you viewing, you can watch all 120 of our current MedNet by going to ccme.osu.edu on your web browser. And if you prefer to get your continuing medical education by podcast, just go to your podcast app and search OSU MedNet21. Also, if you have questions about spine disorders, you can email us by using the Ask a Question icon at the bottom of the med page web page.

Now let's get started with today's webcast, Andy

>> Very good, well thank you so much for having me so today I'm gonna be speaking on common spinal disorders. I think this is important for any physician who sees patients, spine problems are very common, pretty much every clinic you're

gonna see somebody that has something going on with their spine.

We'll talk about history and physical exam findings, imaging modalities, and then ultimately what to do with these patients, where to send them for care. So really the objectives today are to understand basic spine pathology, there's terms we all know here. Spinal stenosis means narrowing around nerves, but it's important to know where that is and if it correlates with the patient's symptoms.

We wanna understand a patient's presenting symptoms, are they just having pain? Are they having numbness, tingling or having weakness, where's that located? And then we wanna understand common treatment options for these patients. So back pain, as I mentioned, extremely common, it's the fifth most common reason for people to seek medical care in an outpatient setting.

84% of adults have had back pain at some point in their lives, and I would venture to say this is probably closer to 100%. 23% of patients have had back pain within the past month. We know there's several risk factors for back pain, smoking, obesity, sedentary lifestyle, advancing age, we certainly have an advancing age population in the United States that is going to become even more common Physically strenuous activities in jobs, sedentary work, so you're sitting a lot, low education, if there's workman's compensation involved, dissatisfaction with your job or things like anxiety and depression.

85% of back pain is non-specific, so we're not able to easily say, this is clearly what's causing it. So, what do we do to evaluate back pain? We want to know what factors are associated with the back pain. So, this can be what makes it better or what makes it worse.

If pain is better when you lay down and worse when you stand up or move, there may be a mechanical component, maybe some spinal instability. Biological pain, such as tumors or other kind of red flag findings. Tends to be worse, like at night or first thing in the morning, and better with activity.

We wanna know where the pain is. Is it center over the spine? Does it locate over the back of the hip? Does it radiate down the leg? Is it more of a radiculopathy kind of picture, like a pinched nerve? Is there associated numbness and tingling? Is there associated weakness?

Or are there bowel and bladder symptoms? Physical exam is key to evaluation for any spine problem. We want to look at the back and look at their postures. So this is very easy. You can have patients stand up and see how they stand. Are they stooped forward or do they have a cathodic posture?

Do they have scoliosis where you can see, tilting of the shoulders or asymmetry in the ribs? You can palpate or percussive is there tenderness? That can be muscular, can be in setting of trauma could be from fractures. We want to do a thorough neurologic exam so we're gonna test major muscle groups, we want to do a sensory exam.

I think gate exam is one of the best exam things I do in clinic. I watch every patient walk. If they can stand from a seated position and walk without a limp, they can walk on their heels, walk on their toes, then I know that their strength is doing pretty well on their legs.

Then we can check reflexes. If they have a compressed nerve, they may be

hyperreflexic. So reflexes are diminished. If they have compression of spinal cord, cervical myopathy, they may be hyperreflexic. So you're getting increased reflexes. We knew straight leg raise. So basically have the patient lie down, lift their leg up, if they have a disc herniation or stenosis, that puts tension across that nerve and recreates their radiating leg pain.

And then we wanna look for nonorganic sentence. So is there overreaction to exam? Does the patient's exam improve when distracted? Is there a breakaway weakness? So they're trying to get you to think that there's more stuff going on than it's actually going on. This doesn't have to be volitional.

They don't have to be trying to trick you. Sometimes it's subconscious. We've all seen these. These are dermatomes. So this is where the spinal nerve roots run as they exit the neck or the low back. And so this can give us a sense of if there's numbness in a certain distribution, what nerves might be affected.

These are not always the same and there is overlap, but this kind of gives us a general sense of what spinal nerve roots may be involved. We also talk about myotomes, so you certainly don't need to memorize this, but you want to know basic muscle groups. And so when we talk about biceps and wrist extension, that can be like a C6 problem.

Are they having foot drop? Is that a L4, L5 problem? Are they having plantar flexion weakness? So the one way I like to find this is watch the patient walk on their toes, if they can't support their weight on one of their feet, maybe s ones affected. So this can kind of further help us localize, what nerve roots are affected, and see if that correlates with imaging.

I think a very important topic is red flags. So, if everyone comes and they say my back hurts you want to find out the ones that, okay this is muscle strain or this is something we can do physical therapy. Or there's some red flags here we need to get imaging now.

Big ones are progressive neurological deficits. So if patient presents with weakness, especially progressive weakness, that's something that we probably shouldn't delay. We need to get MRI imaging, figure out what's going on, and if this is something that needs to be intervened on sooner rather than later. Another big one is bowel and bladder dysfunctions.

So we talk about like Cauda Equina Syndrome. So if someone's having urinary incontinence, can't control their bowel or bladder, this a lot of times can mean that it's a neurosurgical emergency and those nerves need to be decompressed now. Those are very sensitive nerves. If you delay too long, the chances of recovery of bowel and bladder function, they go down.

Is patient having fever? Is there a concern for infection? Infection likes to go to the spine. So osteomyelitis, discitis, we see a lot of it. If patient's having fevers along with their back pain, that might be something that needs, more urgent evaluation. Sudden onset of pain or spine tenderness, that can be fractures doesn't always have to be with trauma.

So patients can get like osteo product compression fractures where they're not doing anything very strenuous, but they have also in the sudden onset of pain. Obviously history of trauma. If they have a serious underlying condition, so if they have infection other places did that spread to the spine?

If someone has an infected knee or hip and then also they're getting back pain, did that infection spread and now they have osteomyelitis discitis in their spine. Patient has a history of malignancy and now they're getting back pain, did that metastasize? If patients have diagnosis of osteoporosis or chronic steroid use, that's going to put them at increased risk of fractures.

So again, like I mentioned they may not have trauma, they may be doing their normal daily activities and then all sudden start getting some back pain related to like an osteo product compression fracture. So lumbar stenosis, we all hear that term. What is it? What does it cause?

So stenosis is narrowing around the nerves. If it's narrow around the nerves, nerves can be irritating, can cause pain, it can cause radiating leg pain, it can cause numbness, can cause weakness if it gets severe enough, and can cause bowel and bladder incontinence. Most of the time degenerative lumbar stenosis does not not get to the point where it causes bowel and bladder incontinence.

The body's pretty good at adapting if this kind of happens slowly, overtime. The time I worry more about bowel and bladder incontinence is with like an acute change, like an acute disc herniation. The classic finding and lumbar stenosis neurogenic claudication. So patient walks they all describe a different, they say legs feel heavy, they feel tired they feel like they're hitting golf from underneath them, they get funny feelings in their legs.

They get numbness, tingling. If they sit down and rest or if they bend over a shopping cart, bend over a walker, symptoms tend to improve. Bending forward tends to open up more space around the nerves. So it's really, when I see a patient and I'm concerned about claudication, I say, how far can you walk?

And if they say, I can walk, three miles, no problem, I'm less concerned about it. If they can say, I can make it from the parking lot in here and then I got to sit down, that's someone that I'm worried about. Maybe they're having this neurogenic claudication. So here's an MRI of a patient with lumbar stenosis.

So on the left we see a sagittal T2 MRI. And the main findings are, you look in the central canal. So, spinal fluid lights up bright white, and then you can see the gray streaks are the nerves. So, the red arrow kind of indicates that's where we have stenosis.

That's where we have pinching of those nerves. So, you can see above and below, plenty of spinal fluid around the nerves. In the middle view there, we have an axial cross-section. This is a pretty normal level. So you can see plenty of spinal fluid around the nerves. Nerves have plenty of space.

And then on the right, the axial is a cross section where that red arrow is. Now we don't see that spinal fluid, so now it's tighter on those nerves. That's lumbar stenosis. So, what are treatment options? Most of the time this isn't an emergency, we can start with things like physical therapy.

You can try steroid injections, see if the patient's doing better. If that stuff's not effective, we have good surgical treatment options. This is typically a laminectomy. So this can be done open, this can be done minimally invasive. Basically, you're removing the lamina and making more space for the nurse in the central canal.

Most of the time this can be done outpatient, so patient can come in, have surgery

go home the same day. And it's a very effective treatment option for neurogenic claudication. What about foraminal stenosis? So, the foramen are where the nerves exit. So, they run in the central canal, and at each level they branch off, exit out the foramen, and then run down the legs.

So foraminal stenosis is narrowing around the neuroforamen where the nerve exits. This does not typically cause neurogenic claudication such as central canal stenosis. This tends to be more radicular leg pain, numbness, tingling can be weakness. The foraminal stenosis does not cause bowel and bladder incontinence. So if I see someone with a wide open central canal just foraminal stenosis, I'm not concerned.

I tell them, you're not gonna lose control of your bowel or bladder, those nerves run in the central canal and exit lower down. So, here's an MRI example of foraminal stenosis. So on the left again, there's our midline view, sagittal view. We do see that there's a fair amount of central canal stenosis at a couple different levels.

In the middle, now we still see spinal fluid around the central canal, but where the red arrows are, those are the foramen where the nerves exit. Now we don't see as much space around there. I really like the view on the right when I'm looking for foraminal stenosis.

So this is a parasagittal view, so over to the side where we see where that nerve exits. So, the nerve is the little gray dot that the arrow is pointing at, and right below that we see that disc bulge into the neural foramen. So that foraminal stenosis can cause radiating leg pain, numbness, tingling, weakness, if it gets severe enough.

Treatment options are different for frameless stenosis. So, just doing a laminectomy, removing the lamina of the central canal, is not gonna do much to open up that neural foramen. Sometimes foramen anatomies can be an option. A lot of times in the lumbar spine, I don't think they work as well as like a laminectomy for central canal stenosis.

You can see on the view in the right, the part of the bone that overlays the foramen is the first set joint. So to really get that neural foramen wide open with surgery typically we're moving that facet joint. If we remove the facet joint, we cause instability which a lot of times necessitates a fusion surgery.

Fusion surgeries are bigger surgeries, so again, we'd like to try all the conservative modalities, physical therapy, target injections, and save fusion for if that stuff is ineffective. So this is an example on that patient of surgery we did for them. So, on the right, you can see a little schematic where that nerve is exiting, the part of the bone that overlies that nerve, and that neural foramen, the facet joint.

So I tried to highlight on the image on the left on the X-ray, the postoperative image, that's where we remove that facet joint. And so if you kinda follow forward from that red arrow, you can see a large space now that's that unroofed neural foramen. The other thing we try to do is by putting inner body grafts, which are those little spacers between the bones, is to restore disc height.

So then if you restore disc height, you can also increase the height of the neural foramen and make more space for that nerve. What about a lumbar disc herniation. So, disc herniation can be different from stenosis. Stenosis, a lot of times can gradually happen over time, it's from bone spurs, disc bulges, arthroscopy in the facet joints, the facets get inflamed and larger, you can get ligamentum hypertrophy.

Disc herniation is typically more of a sudden onset, so patient may be lifting something feel a pop, then get radiating leg pain. Symptoms can be similar, though, they can get back pain, they can get radiating leg pain, they can get numbness, tingling, they can get weakness. Severe disc herniations with compression of the cauda equina, so central canal, those are patients that can get bowel and bladder dysfunction.

So if someone comes in and says yeah, I picked up a heavy box now my leg is killing me and not able to control my bladder, that's one of those red flag findings that this is something that needs to be decompressed immediately, emergently. So here's an example of a patient with a disc herniation.

So on the left, again, our parasagittal view, so the top arrow, you can see that disc herniating out, and actually the bottom arrow, if you look closely, there's a large fragmented disc in that central canal. In the middle view there, now we're really not seeing any spinal fluid around the nerves.

That is actually a large fragmented disc that's right in the spinal canal. So this is someone I'm worried about. They're getting compression of all those nerve roots running. They can have a cauda equina type picture. This is someone that needs emergent surgery. On the right there, you can see our post-operative view.

So now you can see what things look like after we went in, resected that disc herniation. So now we see restored that spinal canal, and now we can see space around those nerves. What about the neck? So, we can get very similar things to the low back and the neck.

So cervical stenosis would be narrowing in the cervical spine. Where the narrowing can cause different issues. So again, if it's narrowing on the foramen where the nerves to exit, typically a patient will present with radiculopathy, so they'll get radiating arm pain, numbness, tingling, they may get weakness in their upper extremities.

If it's in the central canal and the neck, that's where the spinal cord lives. So then we talk about myelopathy. So myelopathy is from compression of the spinal cord. That tends to be more balance problems, coordination problems. So a patient says I just feel off balance when I'm walking, I'm dropping things with my hands, I'm fumbling with buttons, my handwriting isn't very good.

Those are all concerning signs for myelopathy. If a patient has compression of their exiting nerve roots, they might get loss of reflexes or hyporeflexia. If the patient has compression of their spinal cord, they may be hyperreflexic. So you're really seeing those reflexes jump. And one reflux I like is the Hoffman side, basically, you're flicking the distal joint of the middle finger and you're looking for the other digits thumb and other forefinger to jump when you're flicking that.

That can be a sign that there's compression of the spinal cord. So, here's an example of a patient, again, parasagittal MRI of the cervical spine. So, on the left, we see there's a disc protrusion that's going out abutting the spinal cord. On the top view on the right, we see there's a lot of central canal stenosis.

So, this is where the spinal cord is being compressed. So, I'd be worried about myelopathy, I'd be worried about balance problems, coordination problems. On the one on the bottom, now we're looking at more foraminal stenosis. So at this level, I wouldn't be as concerned for the spinal cord, it is getting a little narrow, but now

we're seeing that foraminal stenosis where that nerve is trying to exit on the side.

So this would be someone that would be getting more radicular arm symptoms pain, numbness, tingling, weakness in the upper extremity. So what treatment options do we have for cervical stenosis? Well, I think there's several good options. Again, if you can avoid surgery, that's always best. If we get to the point where if a patient has progressive myelopathy, or conservative modalities are ineffective, then we talk about surgery.

So, surgery can be coming from the front, typically something like an anterior cervical diskectomy and fusion, we're making an incision in the front. Remove that disc, put a spacer in there with a little plate and screws that stabilizes everything, or it can be coming from the back like a posterior cervical laminectomy infusion.

Laminoplasty can be an option. So instead of fusing the patient's spine, we basically make a hinge and open up some more space with the lamina. I'll show some examples of that here in a minute. Artificial discs are an option. They do exist for the low back as well.

They're newer for the low back and haven't been around just long. But artificial disk for the neck, I think, can be a good treatment option in select patients. So typically, these are younger patients, they wanna maintain more normal range of motion. They're not having a lot of neck pain, it's more for ridiculous symptoms.

They may be candidate for cervical artificial disc arthroplasty. So here's some pictures some examples so the two pictures on the left this is someone that underwent a cervical laminoplasty. So they were having myelopathy symptoms so spinal cord compression. These aren't very good for foramina stenosis, but basically we hinge open the lamina to make more space around the spinal cord.

So you can see the little brackets there. View from the front, view from the side that are basically connecting that lamina where we hinged it open. On the right, this is a patient that underwent a cervical arthroplasty or an artificial disc. So the metal in there that you see is a disc that's actually designed to move.

So you can see when they're bending backwards, when they're bending forwards, they're maintaining range of motion at that level. So in younger patients that don't have a lot of arthritis, their facet joints are good. These can be good options to kind of maintain more normal range of motion in their neck.

What about fusion? So, fusion is certainly an option as well. This will depend on where the stenosis is, how many levels, if it's all the levels in the neck, we're kind of limited by how much we can do from the front. So sometimes those patients are gonna require a laminectomy infusion.

So the two images on the left are someone that underwent multi-level laminectomy, basically all the levels in the neck, and then an instrumentation infusion to stabilize things. We found in the past, if we do just a laminectomy in the neck, patient's next one to tip four, they want to cut photos.

So the instrumentation is to maintain their more normal alignment. On the right, two pictures are a patient under Winton and ACDF for an anterior cervical diskectomy and fusion. So ACDS are one of the mainstays of cervical spine surgery. It's effective at central canal decompression. It's also effective at neuroforaminal decompression.

So you can remove bone spurs and osteophytes from the front. You can put spacers into a restore disc height, and that opens up more space around the neural foramen. And then I typically use a plate and screw construct to kind of stabilize that to allow those bones to heal and fuse together.

What about spinal deformity? So I included this topic because these are patients that maybe, 20 years ago, 10 years ago, spine surgeons may have told them, we don't have a good surgical option. Your spine's too bad, surgery's not gonna help. But spinal alignment problems can cause a lot of difficulty for the patient.

It's easy to stand upright. If you're standing straight upright, you can typically stand for a long period of time. If you have a spinal deformity where you're kyphotic or tip forward or you have scoliosis and you're off to the side, your body needs to exert a lot more energy and a lot more effort to maintain a standing posture.

So a lot of times these patients are only able to stand 30 seconds a minute and then they start getting severe pain, they have to sit down. A lot of times spinal deformity is combined with stenosis, foraminal stenosis, disc herniations. A lot of adults that get spinal deformity, they get scoliosis from their degenerative changes.

So, discs wear out, the bones settle on each other, if they settle more on one side than the other, they can start to get some curve in their spine. So I'll go through some cases here. So first case is a 52 year old female. She presents with several years of axial low back pain, so pain in her back, and difficulty standing upright.

She's tried all the conservative modalities, physical therapy, she's tried epidural steroid injections, she's tried radiofrequency ablations, where basically they're targeting the pain nerves around the facet joints. Radio-frequency ablation is I think are a great treatment option for a lot of patients with axial back pain. They consist of two parts basically you go in and numb the medial branches which are branches of nerves that sense pain or on the facade joint.

I tell my patients it's like numbing a toothache lasts the rest of the day. But if they feel a lot better for the rest of the day, that you can do the second part which is a radio-frequency ablation where basically minimally invasive procedure they go home the same day.

They put a little probe down and heats up and blades are burdens and nerve endings that can give you that same pain relief for months up to a few years sometimes. So they can be good options and patients who are trying to avoid a large surgery get their pain doing better.

Unfortunately for her these modalities didn't offer enough pain relief. On exam, she's alert oriented cranial nerves are intact, she has good strength in her upper and lower extremities, good sensation but she does stand leaning off to the left. Here's what her x-rays look like. So looking at her from the side, so these are scoliosis x-rays.

So I get these x-rays, I wanna look at overall alignment. She's not terrible looking at her from the side. She's, for the most part, standing upright. She's a little kyphotic across her thoracolumbar junction. Looking at her from the front, though, she does have significant scoliosis in the thoracic and lumbar spine, and she is leaning off to the left.

So this is the part where she's having to fight to kind of stay centered and not tip

over. On the right, we see an MRI, and so this is that pari-sagittal view MRI, so her central canal is pretty open. But when you get scoliosis, typically on the concavity of the curve, so the inner part of the curve, tend to get narrowing around the foramen.

You can imagine as the bones tip over that way, it starts to get narrow and close in on those nerves. So a lot of times these patients present with radiculopathy from the foraminal stenosis, from the concavity of their curve. We also look at between l4, and ss1 when the spine first starts to take off.

We call that the fractional curve. So a lot of times on the concavity of the fractional curve, in her case on the left, she's gonna get, foraminal narrowing and lumbar radiculopathy from that fractional curve. So what treatment options do we have for her? So this is some surgical planning software that I've been using for the past couple years.

So we know we want to get this patient more balanced, upright, we want to decompress her spinal nerves correct or fractional curve, correct or tho lumbar curve. Keep her in an upright posture, so this surgical planning software helps us simulate a surgery. We simulate what we call osteotomy.

So osteotomies are cuts in the bone that loosen up the spine to allow us to get the spine back in better alignment. We can also simulate inner bodies. So if you looked at the third picture from the left, we have little blue squares in there. So those are simulating inner bodies and how much correction we're going to get from placing inner bodies between the bones.

And then the picture all the way to the right, that gives us an overview of what her spinal alignment looked like before the red line. What our goal is the white line and then the blue is our patient specific implant or rod. So we actually get a rod that's manufactured specifically for this patient.

And then when we do our surgery. That does two things. One is it helps us get that alignment exactly where we want it to be. It also tells us did we do enough, did we do enough correction? If we make our osteotomy cuts and the rod doesn't look like it's gonna fit in, maybe we need to do a little bit more, get that spine closer before getting things locked in place with that rod.

And this is what she looks like after surgery. So, again, preoperatively, our plan, and then what we got with our rod. So, you can see pretty close to what we predicted. And then the views on the right are scoliosis before, and what we were able to achieve as far as her alignment after.

These obviously are very large surgeries. I tell people, the surgeries you know, it's an eight hour surgery, usually in the hospital for about a week. So these are very important to optimize the patient beforehand. Trial the conservative modalities before jumping into surgery. If you can avoid surgeries like this, that's always best.

These are really reserved for patients that don't get better with physical therapy, that don't get better with injections. They're miserable, they can't do the things that they need to be doing to live. Go through another case here. So this is a 62-year-old patient of mine. Again, presents with progressive back pain, radiating leg pain.

She's getting numbness, tingling, weakness in her legs. She's had several falls, she does use a wheelchair, she came to the clinic in a wheelchair. She is able to walk short distances, but not very well. She also has done physical therapy. And she has a

history of a spinal fusion in 2012.

She's having some spasticity, so they've also placed a back lift and pump. On exam, she's alert and oriented, her cranial nerves are intact, she has good strength in her upper extremities. She's diffusely four out of five in her lower extremities, so she does have some weakness, and three out of five in right dorsiflexion and EHL, so she is getting some foot drop on the right side.

And she has a diminished sensation in her bilateral legs, pretty diffusely. I think this is an interesting slide. So, this is over the time course of about two to three years. So on the left you can see she's had a fusion before, the spine looks pretty well aligned.

You can start to see in the next one over to the right, itr's starting to get a little disc height loss. So, at three four disc is starting to wear out, it's starting to get a little bit of bone spurs. The next one to the right, now she's starting to get a little bit of scoliosis.

It's not terrible yet, it's starting to go. And then by the time she saw me, the one all the way to the right, now you can see things are really collapsed down, really starting to get that scoliosis curve. So, this is what her CT and MRI look like.

So, on the left, we have a CT of her low back. As you can see, those discs are really eaten away. It's sitting pretty much bone on bone at L4, 5. There's a lot of retrolisthesis, so L4 is really slipping back on L5. Even the levels above those discs are looking pretty unhealthy.

You're starting to see those endplate changes and stuff like that. On the MRI scan, we see that she's getting a fair amount of stenosis. So with that retrolisthesis, with the bone spurs, she's getting narrowing around those nerves. And then the image on the right, I'm trying to show you what used to be a neural foramen.

So, because that disc is so collapsed and those bones are settled on each other, there's essentially no neural foramen there anymore. So, there's a nerve trying to exit where that red arrow is pointing. It's really getting smashed. So, that's why she's getting that foot drop on that right side.

So, what options do we have for her? So again, we like to start with the conservative modalities physical therapy. She's not responding. We talk about surgery to correct this. So again, using our planning software, we plan our osteotomies, we plan our inner bodies, and we say, how are we gonna get this patient's spine in better alignment?

I think one interesting thing that this planning software allows us to do is, if you look at the center image, so she's really lost that lumbar lordosis, so the curve to stand upright, and so she needs to compensate for that. So, if you look at her thoracic spine, she's really flattening it out cuz she's trying to stand upright.

She doesn't wanna be standing tip forward. So what the planning software allows us to do is estimate what's gonna happen with reciprocal changes. So when we add that lordosis back in her lumbar spine, what's gonna happen to the thoracic spine? Hopefully she's not gonna have to extend that thoracic spine, she's gonna get a little more natural kyphosis in her thoracic spine.

So this planning software really kinda helps us determine what are we gonna do to correct, and then what's gonna happen reciprocally in the rest of the spine. So here's

her surgery. So on the left we can see the scoliosis before and after. Standing much more up right now.

The center image, what she looked like, sagittal alignment, looking at her from the side. Then what we plan to do with surgery, and then the surgery we perform for her. So you can see that what we're talking about where she's flattening your thoracic spine, she's gonna get the reciprocal kyphosis after surgery did happens.

Now she has a more normal curve in her inner thoracic spine. One thing that's extremely important for these patients, especially undergoing large surgeries, is that we monitor them closely, not only before surgery but after surgery, to see did we get the correction we needed? Are they maintaining that?

Are they developing adjacent level problems. So, here's an example of some of the measurements that we do, and the surgical planning software makes it nice because it automates these measurements. So I don't have to sit in clinic and draw all the angles on X-rays, this automates the process for us.

So, in your preoperative visit, we see things like pelvic tilt, how much you're tilting their hips back to try and stand up right. Lumbar lordosis, how much curve they have in their low back. She had about four degrees before surgery. And we know that there's a measurement called pelvic incidence, which kinda gives us a guideline of how much lordosis someone should have.

And we knew that she's about 40 degrees off, so she needs about 40 degrees more lordosis. So, we plan to get her to about 40 degrees. The yellow arrow is what her plan was for the case. And then the blue arrow and the purple arrow are follow-up visits.

So, she's about four months after surgery on the on the first follow up visit, and about eight months after surgery on the second follow up visit. So we can see, did we achieve the correction we wanted? Is it staying? If it's not, if they're starting to tip back forward, are they having a problem?

Are they getting kyphosis above their surgery? Do we get a rod fracture and things are starting to tip back, for things like that. So, it's extremely important to keep close tabs on these patients. I'll see these patients to at least two years, and then usually yearly indefinitely after that.

Last case here, so this is a 54-year-old gentleman presented in my clinic with, again, progressive back pain, difficulty standing upright. He does have a history of MS. So we know if someone has a neurologic condition that can affect posture control, can affect muscles, and that can lead to spinal deformity problems.

He also has a backup pump placed for his MS and spasticity. His exam, he's alert and oriented, his cranial nerves are intact. He does have some baseline four plus out of five right upper and lower extremity related to his MS. He has diminished sensation on the right side as well.

He's not myelopathic, he doesn't have a Hoffman sign. This is a little hyperreflexia in his lower extremities. His gait is very slow and antalgic, and he does have a very kyphotic posture, he's leaning to the right. So this is what he looked like in clinic. So, you can see this is not just a thoracolumbar problem, this is a cervical problem too.

A big problem for these patients is horizontal gaze. It's very difficult to do things, live

life, go to the store, go grocery shopping, if you can't look forward. So this is a very debilitating condition, this is someone that 20 years ago probably wouldn't have a great option for him.

Here's his measurements so we do all the preoperative measurements to figure out what his alignment should be, where he's at now, and then we do our surgical planning. So you can see this is a very large surgery, obviously you need to consult these patients on recovery after. We do our planning, what osteotomy cuts we're gonna need, what interbodies we're gonna need to get this patient back upright.

So on the left you can see he is very far leaning off to the right and looking at him from the side he is very tip forward so he's got a flat low back, also, his cervical spine's very kyphotic. He can't maintain that horizontal gaze. So this is what we did for this patient, this is obviously an extreme example of surgery, but I just wanted to kinda highlight the things that we we're able to do now, safely that probably wasn't an option in years past.

So now you can see he's upright, he's looking forward, and what he looks like from the side. So this is a life-changing surgery. This is someone that's struggling to stand, struggling to walk, go to the store, now they're upright and able to do those activities of daily living much easier, much more comfortably.

So thank you, thank you again for having me, I hope you got something out of this, and yeah, I'm always available, you can email me with any questions or anything.

>> Well, thanks, Andy. I think when many people think about spine surgery, think about surgical incisions whose length is measured in feet rather than inches, how are you incorporating minimally invasive techniques into spine surgery?

>> Absolutely, so, minimally invasive spine surgery is one of those areas that seen a rapid evolution over the past several years. Obviously some of those surgeries I showed are extreme examples of patients that, they need a large open surgery, those are big surgeries. Most patients that need spine surgery, that's not what they're getting.

So minimally invasive techniques, we're really able to target exactly where we need to go through a one or two centimeter incision. A lot of times these are outpatient procedures, you go home the same day, really reduces blood loss, need for post operative pain medications, really speeds recovery. And so if we can target a specific nerve that's getting impinged on and really target that with a minimally invasive procedure, that's a great option for patients.

>> What about robotics in spine surgery?

>> Robotics is another area that's made some rapid evolution over the past several years. And so, in spine surgery, we were a little behind some of the general surgeons as far as some robotic techniques but now there's numerous platforms out there that help us.

We use them as a tool during surgery. So the robots don't do the surgery, but really the goal is to increase precision and accuracy with implants that we're placing. So right now, if I need to put screws in to stabilize the spine, an unstable spine, the robotic platform helps me more accurately place those making it safer for the patient.

I think it's gonna be an exciting next five or ten years in robotics spine surgery as the robots evolve, we're able to do more things like decompressions and stuff like that. So it's a very exciting time.

>> From a structural and functional standpoint, the spine is incredibly complex.

Are you incorporating artificial intelligence into the planning for spine surgeries?

>> We are, and so that surgery planning software that I showed some examples of actually does incorporate artificial intelligence. And the part that's important is the post-operative images, the post-operative outcomes, and so we can learn and the machine learning can learn, if we didn't get our alignment goals just right, what went wrong and what can we modify for the next time we plan to make sure we're more accurately getting that patient's spinal alignment exactly where it needs to be.

>> For the primary care provider who's evaluating patient with back pain, what initial imaging tests should we be ordering?

>> So I think it's a combination of imaging, as well as a thorough history and physical because those really go together. So I always get a good history, things like what makes the pain better or worse.

Is it more of a mechanical kind of thing, is more muscular pain, is it radiating pain, where is it radiating, and then pairing that with a thorough physical exam so are they getting weakness? Can we say this is a certain monotone, this is L4 or is this S1, and then I pair that with my imaging modalities.

I think you can get a lot out of just standard routine X-rays. I like X-rays because patients are upright, they're standing, and so we can see if there's instability that we might not see if the patient is laying down for an MRI or a CT scan, if a disc is wearing out, you might not see the disc, you don't see the nerves on the X-rays, but you get a sense of you're getting disc height loss, you're getting osteophytes or bone spurs.

You can get all those things from X-rays. So I get a very good idea on everything from just a standard set of X-rays. I usually incorporate flexion extension X-rays into cervical as well as lumbar spine cuz then I'm looking for instability, are things moving, are they translating abnormally?

That may correlate with symptoms that we might not see on a MRI scan because the MRI are laying static. The next imaging modality after X-rays is MRI. MRI is really the mainstay of spine imaging. MRI shows us nerves, it shows us the frame issues as a central canal, it shows us the discs, all the soft tissue things that we're looking for.

And then I'm really trying to correlate those MRI findings with what I'm finding based on the patient's history and based on that physical exam.

>> When we discussed how spinal stenosis and foraminal stenosis differ in their clinical presentations, when I've ordered spine MRIs in the past on older patients it's really common to see some degree of stenosis on the radiologist report.

How do you decide whether foraminal or spinal stenosis warrants surgery?

>> Pretty much every MRI scan is gonna say some sort of stenosis, especially in older patients. It's normal to have wear and tear. It's normal to get some

degenerative disc disease. So a lot of times you're looking at a report that says L1-2 there's stenosis, L2-3 there's moderate stenosis, L3-4 there's severe stenosis.

Mild, moderate, severe, there's no great uniform classification for what's mild, what's moderate, what's severe. So that's where correlating it with the patient's symptoms is very important. If it says there's severe stenosis at L3-4 but they don't have any symptoms there, then I don't worry about it. I'm really looking for that correlation with if there's stenosis around the L4 nerve root, and they have numbness along L4, and they have weakness in dorsiflexion.

Those are things that correlate with that imaging finding, and that's gonna lead me to say, all right, there's something that potentially needs this treatment.

>> Does the presence of osteoporosis affect your decision on whether or not to operate on the spine?

>> Absolutely, and it depends on what exactly we're planning to do.

And so osteoporosis, I think it's important in general for screening patients at risk to make sure that they don't run into problems like compression, fractures, and stuff. If I'm planning a laminectomy or a discectomy, a decompression, I worry less about osteoporosis. If I'm planning an instrumented fusion where I'm putting screws and rods in, I tell my patients if those screws and rods get loose, things come apart, we can be in a worse place than before we started.

So I screen all my patients that are getting especially multi-level fusions for osteoporosis. If they have osteoporosis. I'm relying on my bone endocrinology colleagues to evaluate that patient and get them on a bone anabolic agent. Usually for several months before deciding to go to surgery to optimize that bone health and help them heal from surgery.

>> What about BMI? Does the patient's weight affect the surgical decision making or in the outcomes of spine surgery?

>> We know that BMI does affect outcomes. So as BMI goes up, patients can be at increased risk for medical complications and surgical complications. And so, we're currently writing up our series on patients that undergo long segment deformity surgeries, looking at patients with normal BMI versus a high BMI.

We found that, all the patients get better to about the same degree, so when they filter patient reported outcomes, they all get better. Our obese patients, however, did have higher rates of kidney problems after surgery, heart problems after surgery, as well as instrumentation failure, like screws getting loose, or rods fracturing.

So, I think it's important to counsel those patients that, you may be a candidate for surgery. You're gonna have a higher risk of those complications.

>> For our patients who are considering future surgery for spine disorders, what can the primary care provider do to optimize them for surgery and hopefully reduce their chances of complications?

>> Yeah, I think a few things. So I tell people what things are good for your spine are good for you in general. So optimizing blood glucose, optimizing your hypertension. And then the other thing is physical therapy. So a lot of times physical

therapy can help us avoid surgery.

If they're not having those red flags symptoms, and then two, I tell people, even if we get to the point of proceeding with surgery, doing physical therapy before can help with recovery after. So you get the muscles tuned up, get patients mobilized, used to exercising, and that can help with recovery after surgery.

So I think I would say optimize patient medically and then have the patient do some physical therapy.

>> Well after spine surgery, what should the primary care provider tell patients about activity and exercise?

>> So I always tell all my patients in the first six weeks after surgery, pretty much regardless of what you had done walking is the best thing for you.

Lots of walking. If you're tired you're gonna get sore quicker than normal use said surgery so I tell people short trips sit down rest as you get further off from surgery gradually increase the distance and the frequency you're walking. After that time that's when you start to gradually increase activity before that lifting restrictions usually around 10 or 15 pounds.

I tell people not doing a lot of twisting and bending try to keep a neutral posture. After that we'll start increasing activity using those lifting restrictions.

>> We started off today's webcast talking about football injuries in two famous Americans John F Kennedy, and Peyton Manning. You serve as one of the team physicians for the high State University football team.

For our viewers who are also team physicians for high school or college sports, what recommendations do you have for the initial assessment of athletes with back injuries on the field?

>> So I think twofold. The first and foremost thing is to ensure that players that are injured on the field don't become further injured, so it's precautions, so it's.

You're not mobilizing the player, it's maintaining spinal precautions, if they have a helmet in place and you're worried about a neck injury, it's not cranking on the helmet to take it off. It's really maintaining those spinal precautions to help prevent secondary injury. And I think the other critical thing is a thorough neurologic exam.

Is this just pain or are they having neurologic symptoms, if they're having weakness, if they're not able to move? If they're having numbness, tingling, those are things that require urgent evaluation and urgent MRI scans to figure out where the neural compromise is and what we need to do about it.

>> One last question. A lot of the surgeries that you showed us images of had a lot of metal hardware in the backs. What do you tell patients who are planning on traveling as far as going through TSA metal detectors.

>> It's a very common question. So, most of the metal is titanium, so a lot of times it doesn't set off metal detectors.

So I tell them there's no special card you need to carry, you can go through metal detectors just fine, you can get MRI scans is another common question if I have metal screws and rods in my back. Can I not get MRIs anymore? You can get MRIs.

So nothing special you need to do for travel.

>> Well, thanks Andy. We're gonna finish up with a final key point about common spine disorders, Andy.

>> So final point is spinal disorders are very common. Everyone who treats patients is gonna see someone with a spinal problem. Figuring out where that problem is doing a thorough history and physical and seeing if that correlates with imaging is really gonna help you to find where that patient needs to go for treatment what the next treatment steps are.

>> Well, Andy, thanks again for joining us today and for all of you viewing. Don't forget that you can get American Board of Internal Medicine maintenance and certification points for viewing MedNet and then answering the post-test questions following the webcast. And join us next week with infectious disease specialist Dr. Sidney Agnello and infectious disease Pharm D Erica Reed will be here to update us on antimicrobial resistance and antibiotic stewardship.

We'll see you then.