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AMY'S TRANSFORMATION Adult Spinal Deformity Surgery: Flat Back & Proximal Junctional Kyphosis

Meet Amy

Amy is a 52-year-old asthma and allergy doctor from Cynthiana, Kentucky. Over the years, she has suffered degenerative spine problems and had multiple surgeries, which left her bent forward and unable to stand up straight. With her head leaning out in front of her feet, walking was difficult and painful. Amy had a pain pump to help with symptoms, but the pain medicine interfered with her work. Amy felt too medicated to see patients and took a leave of absence to focus on her health (read Amy's story).

Amy also had trouble with weak muscles in her legs (spasticity) and problems lifting her feet. She had numbness and tingling in her arms and clumsiness in her hands. These were all worrisome signs of spinal cord compression in her neck (myelopathy). Her pain doctor urged her to get a consult at Mayfield Brain & Spine.

Understanding Amy's problem

History: During Amy's teenage years, the vertebrae in her upper back grew in a wedge shape, a condition called Scheuermann's kyphosis. This gave her spine a slouched posture. In her 30s, she had surgery to repair stenosis and a damaged disc in the thoracic spine from T10 to L1. Several years later, she developed instability below the previous surgery site. This was stabilized by extending her fusion to L3 with removal of the upper hardware.

In her 40s, she began having problems in her neck and had a discectomy and fusion at C4-5. But several years later, the adjacent discs above and below weakened and she had fusions at C3-4 and C5-6.

She then developed a slipped vertebra at L5-S1. To fix this, she had extension of her fusion down to the sacrum. But the fusion failed (pseudarthrosis), and the hardware was removed.

By the time Amy was in her 50's, she had a cascade of 11 spine surgeries and more than 20 injection procedures (Fig. 1).

"Once I met Dr. Bohinski, I had faith that it was the right answer," Amy said. "He saw the global problem and not just 15 smaller problems. Everybody who looked at me wanted to say, 'Oh, I can fix that level.' I hadn't had anybody tell me they could fix my whole problem before."



Figure 1. Standing X-rays assess alignment of the head, spine, and hips. Front view (left) shows a global left-leaning shift of the trunk. Side view (right) shows a proximal junctional kyphosis at T12-L1 that bends her upper back far forward. The L4 vertebra has slipped forward over L5. She has a loss of the normal curvatures of the spine and a flat lower back from previous fusions.

Technically Amy had *iatrogenic* spine deformity, which means caused by medical treatment. Because each surgery had been targeted to fix a problem at a certain level, her global spinal alignment was completely out of balance.

The spinal curves act like a spring, absorbing the shocks of footsteps and positioning our head naturally over our shoulders and hips. These relationships are critical. Like the game *Jenga*, when the blocks move out of alignment or get "locked" in a bad position, the tower strains and leans out of balance (learn more about <u>Spinal Deformity</u>).

Consult / evaluation

Physical Exam: It was obvious from Amy's appearance that she had significant spinal imbalance. Her head was well forward of her feet — making her a fall risk. She complained of shooting pain in her right hip and leg, and numbness and tingling in the left leg. She had a painful gait when walking and became exhausted easily. She had lower leg weakness and problems using her hands.

Review Imaging: Standing scoliosis X-rays were ordered (Fig. 1). Dr. Bohinski measured her global spinal alignment to find the root cause of her imbalance.

Amy had a positive sagittal balance of about 30 cm (Fig. 2). She had junctional kyphosis of 30 degrees from T11 to L1 at the top of the previous lumbar fusion. Her pelvic incidence was 60°. Instrumentation from L1 to L4 resulted in a flat back deformity. Her lumbar lordosis was only 13° (her normal should be 50-70°). She had a slipped vertebra (spondylolisthesis) of L4 over L5 with notable disc bulge.

More alarming was a large herniated disc in her neck compressing the spinal cord below the previous C6 fusion (Fig. 3).

"Amy originally came to see me with a spinal deformity and pseudoarthrosis in her lumbar spine," said Dr. Bohinski. "However, she clearly was suffering from cervical cord myelopathy and pseudarthrosis in her neck."

Recommendation: Dr. Bohinski advised a cervical spine revision to remove the disc pressing on her spinal cord and redo the fusion from C3-7. He had to fix the neck before he could address her lower thoraco-lumbo-pelvic deformity.

"Sometimes an individual's entire spine problem doesn't make itself known all at once. You're managing parts of the global problem at different points in time. And Amy's disease just kept progressing, one level after the next." Dr. Bohinski



Figure 2. Normal spinal balance (left) and Amy's spinal balance (right). Diagnosis: Iatrogenic spine deformity

- Flat back syndrome from a L1-L4 fusion
- Spondylolisthesis at L4-L5
- Proximal junctional kyphosis at T12-L1
- Pseudoarthrosis in neck at C3-4 and C5-6
- Cervical degenerative disc disease



Figure 3. CT scan (left) shows pseudarthrosis (red arrow) at C3-4 and C5-6. MRI scan (right) shows a large herniated disc below the C5-6 fusion compressing the spinal cord.



Figure 4. Summary of Amy's 3 surgeries to fix the previously failed fusions and restore her spine to normal alignment.

Custom treatment plan / options

Surgery 1. Neck revision of failed fusions. Amy's myelopathy symptoms needed to be addressed quickly. A revision anterior cervical discectomy and fusion was performed. First, the old plates and screws were removed. The disc spaces were cleaned out and new bone graft material (from Amy's hip) was inserted. The new herniated disc at C6-7 was removed and the cord and nerves decompressed. A new cervical plate from C3-7 would hold it together while fusion occurred. Because of her history of osteoporosis and failed fusion, Amy wore a bone growth stimulator and a rigid neck brace for three months while fusion occurred. (Learn more about <u>ACDF</u>)

During recovery, she worked on improving her bone health with Forteo, calcium, and vitamin D to get ready for the next surgery.

Surgery 2. Anterior "shim" correction.

Five months later, Amy returned to the hospital for a two-day staged operation. On day 1, she underwent anterior lumbar interbody fusion (ALIF) to correct the slipped vertebrae at L4-L5-S1 (Fig. 4). An incision is made in the front of the belly. A vascular surgeon cleared a path (retroperitoneal) to the spine, moving aside the vessels to the legs. The spine surgeon removed the damaged discs and inserted a wedge-shaped cage filled with bone graft and bone-growing proteins. The cage or "shim" restores the height between the vertebrae and corrects the curve (lordosis). The surgery took two hours. (Learn more about ALIF)

Surgery 3. Posterior deformity correction.

The next morning, Amy underwent major deformity surgery. An incision was made down the middle of her back. The muscles on either side of the spine were reflected off the bones. The old rods and pedicle screws at L1-L4 were removed.

A CT scan of Amy's spine was taken in the OR and uploaded into an image-guidance system. The system uses infrared cameras to "see" the trajectory of screws on the computer monitor (Fig 5). The surgeons would accurately place 14 pairs of pedicle screws from T4 to S1. They also placed long iliac screws into the pelvis so that the construct load would be distributed to the hip bones.

The lamina and facet joints were opened from T4-T8 to relieve compression. Also, decompression laminectomies were done at L1-L3.

A key part of the surgery is the pedicle subtraction osteotomy. A wedge of bone is cut out of the L2 vertebra. The upper and lower edges of the hollow wedge are brought together and closed like a hinge. This hinge gives about 30° of correction to the global spinal balance and reverses Amy's forward kyphosis. During this delicate step, evoked potential monitoring of the spinal nerves and cord alerts the team of any pinching or change in nerve function.

Next a cobalt chromium rod is shaped and connected to the pedicle screws starting at S1 all the way up to T4. The pedicle screws pull each vertebra into alignment against the rod.



Figure 5. Image-guidance helps the surgeon efficiently place the 28 pedicle screws in Amy's surgery.

The last step is drilling the surface of the bone along the rods to create a postero-lateral fusion bed. The bone chips and allograft material were overlaid to make a fusion. The muscles and skin were then closed.

Journey to Recovery

Hospital stay: Amy stayed in the ICU for two days and then was moved to a regular room for five days. A custom-molded brace was made of her body torso to match her new spine alignment.

She had to practice how to get in and out of bed, use a walker, and use the toilet and shower. She was walking around the hospital corridor within a few days. After a week, she was discharged and went home.

First 2-4 weeks: Amy boiled her expectations down to three basic goals:

- First survive.
- Second avoid the painful staph infections that set back previous recoveries.
- Third recover a freedom of movement she had not felt in years.

For the next 3-6 months, there could be no bending, lifting, or twisting of her back. Amy wore a custom-molded, neck-to-waist brace for three months. She only took it off to sleep or shower. She also wore a bone growth stimulator for four hours a day over the brace.

Her days were focused on managing the pain with periodic icing, following a medication schedule, and moving / walking every hour or two. Sleep, particularly turning over and getting in and out of bed, was an issue for several months.

She had periodic follow-up appointments and Xrays to check on the fusion progress and whether her symptoms were improving (Fig. 6).



Figure 6. Post-op standing X-rays show the final picture of the deformity correction surgery and a restoration of physiologic spinal balance.

After three months: Amy gradually weaned from the pain medication and wearing the brace. She underwent six weeks of physical therapy.

The sciatic pain shooting down her legs had resolved. However, the weakness in her leg muscles and the pins and needles feeling (neuropathy) would take more time.

After six months: To build strength, Amy slowly worked her way up to swimming 30 minutes, three to five times a week. Nine months after surgery, she was cleared to go back to work.

What are the risks of surgery?

No surgery is without risk. General risks of any surgery include bleeding, infection, blood clots (deep vein thrombosis), and reactions to anesthesia. Specific risks related to spine deformity surgery may include:

- Injury to abdominal organs
- Injury to large blood vessels
- Vertebrae fail to fuse
- Hardware fracture
- Bone graft migration and settling
- Adjacent segment disease
- Nerve damage or persistent pain.



Figure 7. Amy's recovery program included strengthening and walking to rebuild her deconditioned core muscles.

Amy's Decision

Amy focused on finding a surgeon who could envision a global solution to the challenges her complex spine disease presented. Amy said. "My biggest fear was not that he'd say, 'There are 100 things wrong with you,' but that he'd say, 'There's nothing wrong with you."

She also was determined to avoid a recurrence of staph infections that had plagued her with previous surgeries. She even checked online for infection rates of neurosurgeons she was considering.

"Because the necessary expertise wasn't available in Lexington, I researched several other practices."

Once she met Dr. Bohinski, the two doctors bonded over their shared curiosity about the complexity of the spine solution she needed.

What Amy's Life Looks Like Now

If Amy had to confront her 2015 spine challenges again, what would she do differently? "I would find Dr. Bohinski way before I did," she said. "I needed a fresh eye. I felt like at the time, I had doctors who were compassionate, who seemed motivated to help me. In retrospect, I needed someone who would look at the global picture."

For those who would follow her on the journey of complex spine surgery, Amy suggests setting simple goals that will restore basic movements and the ability to maintain a quality of life.

"My goal was to just maintain my independence," she said. "I think I have done that."

Sources & links

If you have more questions, please contact Mayfield Brain & Spine at 800-325-7787 or 513-221-1100.

Glossary

allograft: bone from an organ donor, collected and stored by a bone bank. The donor graft has no bone-growing cells.

autograft: living bone. The marrow contains bonegrowing proteins. It can be collected from drillings during the surgery or taken from the hip as an iliac crest bone graft.

BMA (bone marrow aspirate): living bone marrow, collected with a syringe from the hip (iliac bone) or vertebra. It is relatively painless compared to an iliac crest graft.

BMP (bone morphogenetic protein): sometimes added to bone-graft material to stimulate bone growth naturally in the body.

cellular bone matrix: allograft from an organ donor that contains bone-growing stem cells. The putty is shaped and added to grafts.

decompression: removes the roof of the spinal canal (laminectomy) and enlarges the spaces where the nerve roots exit the canal (foraminotomy).

fusion: to join together two separate bones into one to provide stability.

osteotomy: a procedure in which spinal segments are cut and then realigned. Smith-Peterson osteotomy trims the facet and spinous process. Pedicle subtraction osteotomy removes the pedicle and a wedge of bone from the vertebra body.

pseudoarthrosis: failure of the bones to fuse after surgery; also called non-union.

pedicle: part of the vertebra, shaped like an arch that connects the anterior and posterior segments of each vertebrae.

pedicle screw: screw placed posteriorly across the pedicle into the anterior part of the vertebral body, used as an anchor for the spinal rod.

proximal junctional kyphosis: a complication after surgery in which the vertebra at the top of a long rod fusion angles forward or fractures due to stress.



Meet Robert Bohinksi, MD, PhD

Neurosurgeon, Fellowship-Trained in Complex Spinal Deformity Surgery

This case study is one patient's healthcare experience. Every patient is unique and must be evaluated individually and globally. The size of the curve does not equal big surgery. Sometimes big problems need small fixes, and small problems need global fixes. ©2021 Mayfield Clinic.

If you have scoliosis or other spine deformity, start with us.

Mayfield supports one of the largest and most experienced networks of complex spine specialists in the United States. Our team includes board-certified physicians in neurosurgery and physical medicine & rehabilitation, advanced practice providers, and licensed physical therapists.

Complex problems need carefully planned solutions.

We begin with a history of your symptoms and prior treatments and assess your physical condition. Standing x-rays and other scans are taken. We measure your global spinal alignment to find the index tipping point. Cases are discussed at our weekly Spine Conference where multiple specialists share opinions. Then a custom, carefully planned solution is offered to restore your spinal balance.

Not every patient needs a complex reconstruction. In some cases, a targeted minimally-invasive surgery corrects the problem. A physical therapy and bone health program are always advised. Together, we tailor a treatment plan to fit your goals and improve function and mobility.

Our Complex Spine Team



Front: Zachary Tempel, MD; Bryan Krueger, MD; Brad Curt, MD; Robert Bohinski, MD, PhD; **Back:** Michael Kachmann, MD; William Tobler, MD; Randall Hlubek, MD

To make an appointment, call 513-221-1100 or 800-325-7787.

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