Revision thoracolumbar surgery for flat back deformity: staged ALIF and posterior column osteotomies to avoid three-column osteotomy

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Three-column osteotomies (3COs) can achieve significant alignment correction when revising fixed sagittal plane deformities; however, the technique is associated with high complication rates. The authors demonstrate staged anterior-posterior surgery with L5–S1 ALIF (below a prior L3–5 fusion) and multilevel Smith-Petersen osteotomies to circumvent the morbidity associated with 3CO. The patient was a 67-year-old male with three prior lumbar surgeries who presented with back and leg pain. Imaging demonstrated lumbar flat back deformity and sagittal imbalance. The narrated video details key radiological measurements, operative planning and rationale, surgical steps, and outcomes. The patient provided written, informed consent for publication of this illustrative case.

The video can be found here: https://youtu.be/wv4W9D9fUPc.

**KEYWORDS** adult spinal deformity; anterior lumbar interbody fusion; flatback deformity; revision spine surgery; scoliosis; video

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Transcript

Three-column osteotomies are useful for revision spine surgery but have high complication rates. To avoid this morbid technique, we used a staged anterior-posterior approach with L5–S1 ALIF and multilevel Smith-Petersen osteotomies for deformity correction.

0:42 History and physical

A 67-year-old male presented with back and leg pain. He had three prior lumbar surgeries including a posterior instrumented arthrodesis from L3 to L5. Standing scoliosis films demonstrated global coronal alignment and a thoracolumbar major curve measuring approximately 17°. SVA measured 9 cm. Pelvic tilt was 42°. Pelvic incidence was 71°. Lumbar lordosis was 25°. Thoracic kyphosis was 31°. CT myelogram demonstrated advanced degenerative changes at multiple levels, especially the proximal adjacent levels L1–2, L2–3, as well as T11–12, and the distal adjacent level L5–S1. The patient had high pelvic incidence. We planned to undershoot the PI-LL mismatch and correct lumbar lordosis to approximately 60°. CT scout image is shown at the top right. Given the fixed plane deformity, we could utilize an L4 extended PSO. However, there was a vacuum disc below the prior fusion of reasonable height. We planned to perform a staged anterior-posterior approach with an ALIF at L5–S1 and a posterior revision from T10 to pelvis with Smith-Petersen osteotomies above the prior L3–5 fusion.

2:03 Stage 1 ALIF

The patient was positioned supine on a flat-top Jackson table with arms out. An 8-cm left paramedian incision was made between the umbilicus and symphysis pubis. A standard approach to the L5–S1 disc space was taken. Rectus muscles were mobilized and the retroperitoneal space was entered. Fluoroscopy confirmed that the L5–S1 level was
exposed. Left common iliac artery and vein are visual-
ized. Middle sacral artery has been ligated between silk
sutures and clips. Discectomy was performed and trials
were utilized to determine graft size. A 25° hyperlordo-
tic titanium cage was filled with BMP and inserted into
the disc space. To facilitate cage stability, a 5 × 22.5–mm
screw was placed into the S1 endplate. The cage was still
able to be compressed posteriorly during the subsequent
stage. Fluoroscopy confirmed adequate placement. Stan-
ard closure was performed and initial recovery was un-
eventful.

3:06 Recovery from stage 1

Standing scoliosis films were obtained on postopera-
tive day 3. Global sagittal alignment was 8.5 cm. Pelvic tilt
improved from 42° to 30°. Lumbar lordosis was improved to
45°. Thoracic kyphosis remained stable at 31°.

We felt we achieved enough correction that the stage
2 posterior revision would utilize Smith-Petersen osteoto-
 mies without the need for a pedicle subtraction osteotomy.
Details of the posterior revision will be described by my
colleague Dr. Marino.

3:43 Stage 2 incision and screw placement

For the second stage the patient was positioned prone.
An incision was planned. Posterior elements extending
from T10 through the ilium were exposed, including pre-
viously inserted Steffee plates from L3 to L5, which were
removed. Using anatomical landmarks, T10 through S1 as
well as iliac screws were placed freehand. Intraoperative
ClIOS spin imaging confirmed appropriate screw place-
ment without breaches.

4:06 Smith-Petersen osteotomies

Smith-Petersen osteotomies were then performed at L1–2
and L2–3. A high-speed drill and osteotome was used to
remove the posterior elements at the level of the pars interar-
ticularis en bloc, achieving a Schwab 2 osteotomy.
A Smith-Petersen osteotomy was also completed at
L5–S1 at the site of previous decompression.

4:44 T11 laminectomy

A T11 laminectomy was performed by drilling lateral
troughs that were then completed with Kerrison rongeurs.
The lamina was removed. Thickened ligamentum flavum
was resected with an Adson rongeur. Adequate decom-
pression was confirmed.

5:15 Rod placement

Six-millimeter cobalt chromium rods were cut to span
T10 to ilium. We select CoCr rods for potential increased
biomechanical construct strength during correction of
adult deformities. Gradual rod bending was conducted to
correct spinal alignment. With appropriate osteotomies to
release the spine, it should bend and conform to its new
alignment dictated by the contoured rods. The surgeon
bends the rod for lumbar lordosis restoration. The green
iliac connector was utilized as we slide the primary rod
on the right. Locking caps were placed and tightened with
compression applied across the SPO levels to further in-
crease lordosis.

6:06 Accessory rod placement

Attention was then turned to accessory rod placement.
Side-to-side connectors were placed at T12–L1 and be-
tween the S1 and iliac screws to span and reinforce the
lumbosacral junction. Accessory rods were cut, bent, and
locked in place. Although it would have been preferable
to stagger the superior connectors to distribute stress and
augment transitional stiffness, this was prevented by the
planned tether and the osteotomy.

6:42 Tether placement

A tether was then placed. Holes were drilled at the base
of the T9 and T8 spinous processes. The tether was passed
through the interspinous ligament at T10–11 and then
passed through the spinous processes of T9, then through
T8, back through T9, and back through the T10–11 in-
terspinous ligament. The tether was secured to the rods and
tensioned, being careful to avoid twists in the tether. Ex-
cess tether was cut.

8:17 Conclusion of operation

Decortication was performed and BMP was placed. Al-
though this is an off-label use, BMP has been shown to
promote long-segment fusion in spinal deformity. A mix
of autograft and allograft was placed to complete the ar-
throdesis.

8:40 Postoperative course

Global coronal alignment remained adequate. Global
sagittal alignment improved to 3.5 cm. Pelvic tilt de-
creased to 26°. Pelvic incidence remained stable at 71°.
Lumbar lordosis increased to 59°, and thoracic kyphosis
increased to 41°. Postoperative recovery from stage 2 was
uneventful. The patient was ultimately discharged home 7
days after stage 2 with improved back and leg pain. This
improvement persisted at his 6-week follow-up visit.

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Disclosures
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