

Lateral Interbody Fusion for Hyperlordosis and Negative Sagittal Vertical Axis Because of Accordion Phenomenon

A Case Report

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Abstract

Case: The accordion phenomenon is defined as the difference in the disc space observed on x-ray or computed tomography images taken in both standing and supine positions, which results in a discrepancy of local spinal alignment. Oblique lateral interbody fusion (OLIF) is a less invasive method of potentially correcting both coronal and sagittal spinal alignment. We present the case of a 66-year-old woman with rheumatoid arthritis treated with OLIF for degenerative disc disease presenting with hyperlordosis and negative sagittal vertical axis (SVA) because of the accordion phenomenon.

Conclusion: OLIF for severe degenerative disc disease presenting with hyperlordosis and negative SVA because of the accordion phenomenon may be effective.

Adult degenerative scoliosis is associated with disability and low back pain, and surgical treatment improves patient satisfaction¹.

The accordion phenomenon is defined as the difference in the disc space observed on x-ray or computed tomography (CT) images taken in both standing and supine positions, which results in a discrepancy of local spinal alignment. Moreover, this phenomenon occurs in advanced degeneration of the intervertebral disc with vacuum phenomenon and is considered to cause mechanical low back pain^{2,3}.

We report a case of adult degenerative scoliosis with hyperlordosis in the lumbar spine and negative sagittal vertical axis (SVA) on standing radiography, resulting from the accordion phenomenon treated with oblique lateral interbody fusion (OLIF) and posterior pedicle screw fixation according to lumbar lordosis (LL) in the supine position.

The patient was informed that data concerning the case would be submitted for publication, and she provided consent.

Case Report

A 66-year-old woman presented to our institution complaining of chronic low back pain, right leg numbness, and left buttock pain. Physical examination revealed no motor neurological deficits.

Her medical history revealed that she was under treatment for rheumatoid arthritis with celecoxib (200 mg per day), iguratimod (25 mg per day), and prednisolone (4 mg per day).

On x-rays taken in the standing position, L1-4 Cobb angle, C7-central sacral vertical line (C7-CSVL), SVA, pelvic incidence (PI), pelvic tilt (PT), LL, PI-LL, cervical lordosis (CL), thoracic kyphosis (TK), O-C2 angle, and proximal femur angle (PFA) were 21°, 30°, -92 mm, 60°, 26°, 75°, -15°, 15°, 43°, 7°, and 0°, respectively (Figs. 1-A, 1-B, and 1-C; Table I).

This study was approved by the institutional ethics committee.

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Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJS/CC/B847>).

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Keywords accordion phenomenon; hyperlordosis; negative sagittal vertical axis; oblique lateral interbody fusion

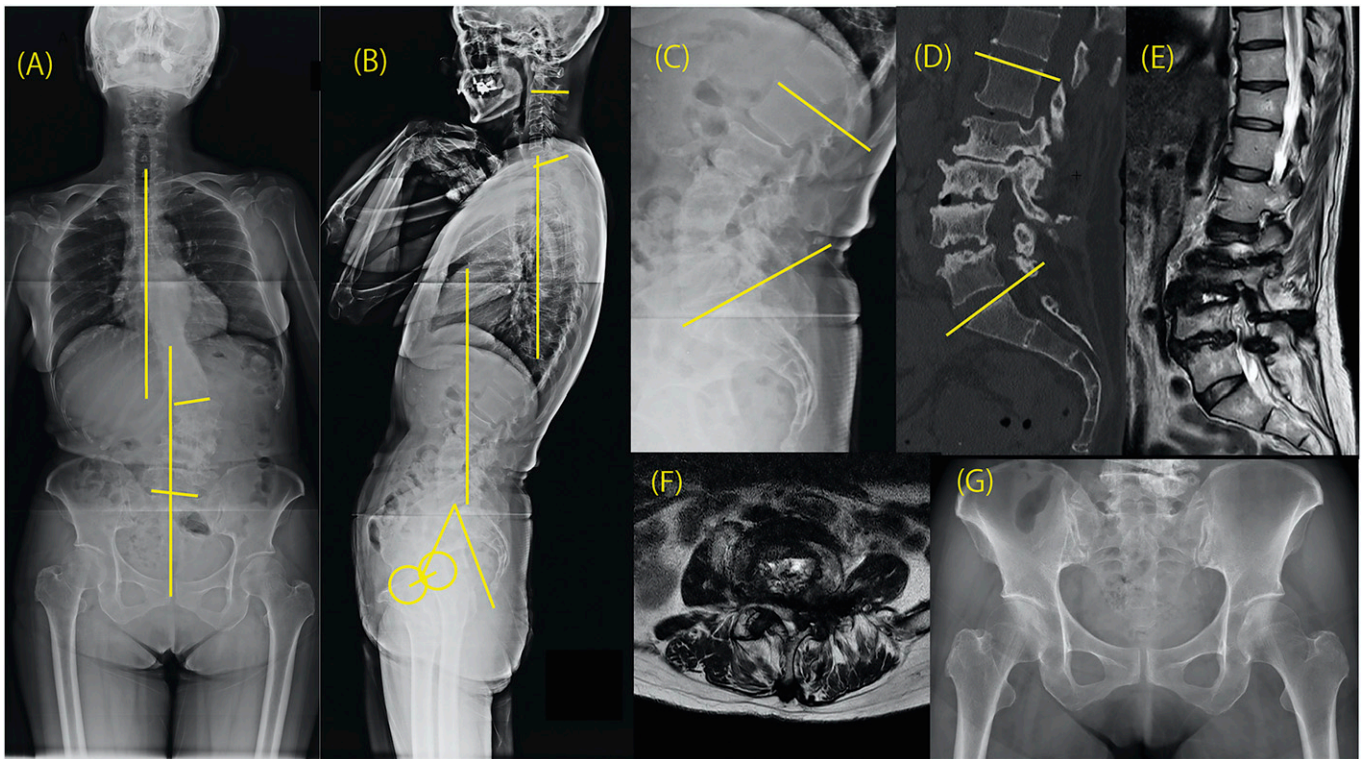


Fig. 1

Preoperative x-ray, CT, and MRI. (**Fig. 1-A**) In standing coronal x-ray, the L1-4 Cobb angle was 21° , and C7-CSVL was 30 mm. (**Fig. 1-B**) In standing sagittal radiographs, SVA, PI, PT, and CL were -92 mm, 60° , 26° , and 15° , respectively. (**Fig. 1-C**) Magnified standing sagittal x-ray images. LL was 75° , and PI-LL was -15° . (**Fig. 1-D**) In sagittal reconstruction of CT in the supine position, the LL was 52° , and the PI-LL was 8° . Vacuum phenomena with subchondral sclerosis were observed in L2/3/4/5. (**Fig. 1-E**) In sagittal T2-weighted MRI, intervertebral fluids were observed in L2/3/4/5. (**Fig. 1-F**) Axial T2-weighted MRI of L4/5 revealed left lateral recess stenosis and foraminal stenosis. (**Fig. 1-G**) Hip joint x-ray before surgery. No apparent joint destruction was detected. C7-CSVL = central sacral vertical line, CL = cervical lordosis, CT = computed tomography, LL = lumbar lordosis, MRI = magnetic resonance imaging, PI = pelvic incidence, PT = pelvic tilt, and SVA = sagittal vertical axis.

CT revealed that the presence of vacuum phenomena with sclerosis of vertebral body end plate in L2/3, L3/4, L4/5, and LL was 52° . The PI-LL in the supine position was 8° (Fig. 1-D; Table I). Magnetic resonance imaging showed left lateral recess stenosis and foraminal stenosis in L3/4 and L4/5 (Figs. 1-E and 1-F). Her hip range of motion was nearly normal. Neither her joint space narrowing nor joint destruction was detected on her hip joint x-ray before surgery (Fig. 1-G).

She underwent conservative treatments for 9 months including wearing custom-molded brace and injections to L3/4 intervertebral disc; however, low back and left buttock pain did not improve. After initiating teriparatide ($28.2 \mu\text{g/day}$, twice per week, subcutaneous injection) for osteoporosis for 1 month, we planned a 2-stage surgical treatment. In the first stage, we performed (OLIF, Clydesdale PTC Medtronic Sofamor Danek) of the L2/3, L3/4, and L4/5 intervertebral spaces⁴. Three days after the initial surgery, we performed posterior fusion (CD Horizon Solera Medtronic Sofamor Danek) from L2 to L5 with decompression at the L3/4 and L4/5 levels. Rod bending was performed according to LL in supine CT before surgery.

After the surgery, her low back pain improved from 5 to 1 on the visual analog scale, and her left buttock pain was

gradually relieved. She was discharged from the hospital while walking with a cane 3 weeks after the second surgery. On x-ray taken in the standing position, satisfactory sagittal balance and coronal balance were achieved; L1-4 Cobb angle, C7-CSVL, SVA, PI, PT, LL, PI-LL, CL, TK, O-C2 angle, and PFA were 12° , 3 mm, 20 mm, 60° , 28° , 51° , 9° , 33° , 44° , 10° , and 6° , respectively (Fig. 2; Table I).

Discussion

Sagittal deformity of the spine has gained attention for its correlation to negative health-related quality of life and often necessitating posterior long fusion of the thoracic to the ileum⁵. According to Scoliosis Research Society–Schwab classification, SVA < 4 cm and PI-LL within 10 is considered an adequate sagittal modifier⁶. In addition, treatments for negative SVA and hyperlordosis are limited. Reverse Smith-Peterson osteotomy, an uncommon technique reported by Lewis et al.⁷, in which anterior shortening with wedge vertebral osteotomy and posterior lengthening with facet joint osteotomy, was performed. Placing cages into damaged disc spaces usually makes lumbar spine stable and lordotic. Our concern was that placement of cages might make her lumbar

TABLE 1 Preoperative and Postoperative Spinal Parameter*

	Preoperative	Postoperative
Cobb angle (°)	21	12
C7-CSVL (mm)	30	3
SVA (mm)	-92	20
PI (°)	60	60
PT (°)	26	28
LL (standing) (°)	75	51
LL (supine) (°)	52	51
CL (°)	15	33
TK (°)	43	44
O-C2 angle (°)	7	10
PFA (°)	0	6

*C7-CSVL = central sacral vertical line, CL = cervical lordosis, LL = lumbar lordosis, PFA = proximal femur angle, PI = pelvic incidence, PT = pelvic tilt, SVA = sagittal vertical axis, and TK = thoracic kyphosis.

spine more lordotic. That is why we separated her surgery into 2 stages to see whether her first operation of OLIF made her lumbar spine extraordinarily lordotic or not. Fortunately, her LL was not much changed and remained ideal on CT after first surgery. We believed that we did not have to do some special technique such as reverse pedicle subtraction osteotomy to make her spine kyphotic on the second operation.

The accordion phenomenon was first described by Sola et al. for treating percutaneous cement discoplasty¹. This phenomenon is defined as the difference in the disc space observed on x-ray or CT images taken in both standing and supine positions, which results in a discrepancy of local spinal alignment. Moreover, this phenomenon occurs in advanced degeneration of the intervertebral disc with vacuum phenomenon and is considered to cause mechanical low back pain. Classification of intervertebral vacuum phenomenon was determined according to the distribution of the air in the disc space and to the existence of subchondral sclerosis in the vertebral body. The accordion phenomenon is frequently observed when the air in the disc space rate is higher than two-thirds and subchondral sclerosis is noted².

In the present case, although LL in the supine position was normal, a vacuum phenomenon with subchondral sclerosis in L2/3, L3/4, and L4/5 was observed, resulting in hyperlordosis, negative SVA, and PI-LL mismatch in the standing position.

Lateral lumbar interbody fusion is less invasive and performed to treat degenerative lumbar diseases^{8,9}. We considered that OLIF with posterior fixation for L2/3/4/5 presenting the accordion phenomenon can achieve good spinal alignments when LL observed in the prone CT was matched with PI.

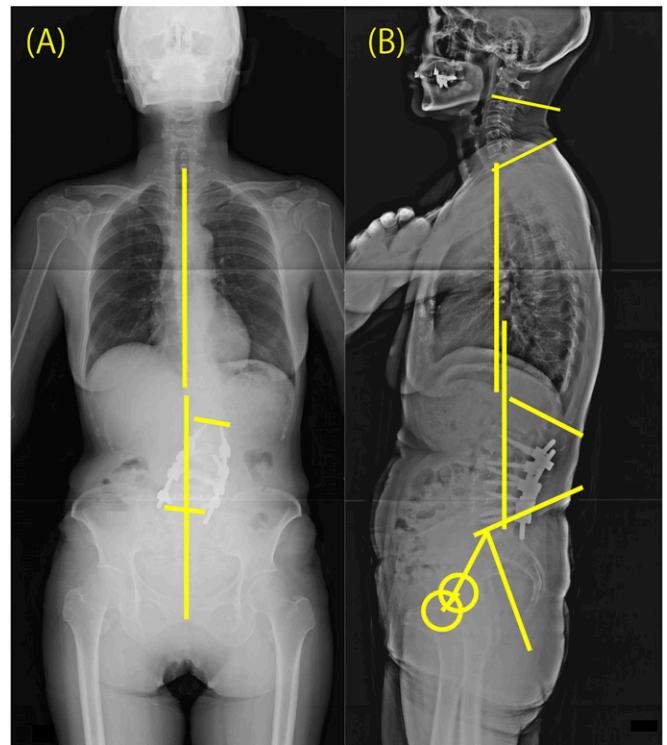


Fig. 2

Postoperative x-ray (**Fig. 2-A**) In standing coronal x-ray, the L1-4 Cobb angle was 12°, and C7-CSVL was 3 mm. (**Fig. 2-B**) In standing sagittal x-ray, SVA, PI, PT, LL, PI-LL, and CL were 20 mm, 60°, 28°, 51°, 9°, and 33°. C7-CSVL = central sacral vertical line, CL = cervical lordosis, LL = lumbar lordosis, PI = pelvic incidence, PT = pelvic tilt, and SVA = sagittal vertical axis.

In conclusion, minimally invasive anteroposterior fusion for severe degenerative disc disease presenting with the accordion phenomenon may be effective. ■

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