JOURNAL OF NEUROSURGERY:
Case Lessons

J Neurosurg Case Lessons 3(23): CASE2296, 2022
DOI: 10.3171/CASE2296

Utilization of lateral anterior lumbar interbody fusion for revision of failed prior TLIF: illustrative case

Ghani Haider, MD,[1] Katherine E. Wagner, MD,[1] Venita Chandra, MD,[2] Ivan Cheng, MD,[3] Martin N. Stienen, MD,[4] and Anand Veeravagu, MD[1]

Departments of [1]Neurosurgery, [2]Vascular Surgery, and [3]Orthopedic Surgery, Stanford University, Stanford, California; and [4]Department of Neurosurgery & Spine Center of Eastern Switzerland, Cantonal Hospital, St. Gallen, Switzerland

BACKGROUND The use of the lateral decubitus approach for L5–S1 anterior lumbar interbody fusion (LALIF) is a recent advancement capable of facilitating single-position surgery, revision operations, and anterior column reconstruction. To the authors' knowledge, this is the first description of the use of LALIF at L5–S1 for failed prior transforaminal lumbar interbody fusion (TLIF) and anterior column reconstruction. Using an illustrative case, the authors discuss their experience using LALIF at L5–S1 for the revision of pseudoarthrosis and TLIF failure.

OBSERVATIONS The patient had prior attempted L2 to S1 fusion with TLIF but suffered from hardware failure and pseudoarthrosis at the L5–S1 level. LALIF was used to facilitate same-position revision at L5–S1 in addition to further anterior column revision and reconstruction by lateral lumbar interbody fusion at the L1–2 level. Robotic posterior T10–S2 fusion was then added to provide stability to the construct and address the patient's scoliotic deformity. No complications were noted, and the patient was followed until 1 year after the operation with a favorable clinical and radiological result.

LESSONS Revision of a prior failed L5–S1 TLIF with an LALIF approach has technical challenges but may be advantageous for single position anterior column reconstruction under certain conditions.

https://thejns.org/doi/abs/10.3171/CASE2296

KEYWORDS revision spine surgery; spinal instrumentation; TLIF; ALIF

Revision spinal surgery is uniquely challenging, and patients are often affected by pseudarthrosis, infection, hardware complications, and deformity.[1] An anterior approach to the spine in the form of anterior lumbar interbody fusion (ALIF) is an effective, safe, and widely used tool for segmental lordosis correction and indirect decompression.[1–3] Its advantages include access via a virgin corridor in case of previous posterior spine surgery, the ability to resect the anterior longitudinal ligament to restore lordosis, and the insertion of a large-footprint interbody cage to promote fusion, especially in the setting of prior pseudoarthrosis.[1,2,4,5]

Its more recent variation, lateral anterior lumbar interbody fusion (LALIF), which is performed using the anterolateral retroperitoneal approach in lateral decubitus position, has been successfully used in select circumstances.[6,7] The LALIF approach is a true L5–S1 anterior approach to the disc space in the lateral position. It facilitates single-position surgery, including both anterior and posterior column reconstruction and, as a result, increases operative efficacy and efficiency.[7–10]

Although this technique is increasingly used by surgeons for various reasons, to the best of our knowledge it has not been described to salvage previous posterior interbody fusion.[2,6,11–15] The challenges associated with vessel dissection from the anterior approach in the lateral position are even greater in the setting of prior posterior interbody surgery given some degree of anterior inflammation and scarring associated with even a posterior interbody technique. We report the case of a patient with prior extensive lumbar surgery and sagittal deformity in which LALIF was safely applied to successfully address

ABBREVIATIONS ALIF = anterior lumbar interbody fusion; LALIF = lateral anterior lumbar interbody fusion; LL = lumbar lordosis; LLIF = lateral lumbar interbody fusion; PM = pelvic mismatch; PT = pelvic tilt; SS = sacral slope; TLIF = transforaminal lumbar interbody fusion.

INCLUDE WHEN CITING Published June 6, 2022; DOI: 10.3171/CASE2296.
SUBMITTED February 25, 2022. **ACCEPTED** April 11, 2022.

pseudoarthrosis after failed transforaminal lumbar interbody fusion (TLIF) at the L5–S1 level and facilitate single-position anterior column surgery.

Illustrative Case

A 68-year-old woman presented to our clinic after having undergone L2–S1 posterior spinal fusion and TLIF at each interbody space. She had increasing severe back and leg pain as well as worsening posture. Imaging revealed pseudarthrosis, loss of lumbar lordosis (LL) with worsening coronal scoliotic deformity superior to the construct with a Cobb angle of 22°, and proximal junctional kyphosis and sagittal imbalance (Fig. 1). Her preoperative spinopelvic parameters were as follows: pelvic incidence 55°, LL from T12 to S1 37°, pelvic mismatch (PM) 19°, pelvic tilt (PT) 32°, and sacral slope (SS) 23°, and her C7-sagittal vertical axis (SVA) was positive at +6 cm.

Because conservative treatment options had failed and her deformity was progressive, we considered her a candidate for revision spine surgery. Due the patient's body mass index of 38.4 and previous posterior decompression and fusion, we planned to address the anterior column with an anterolateral approach. Based on vascular anatomy on prior lumbar spine magnetic resonance imaging (Fig. 2), we opted for single-position anterior column reconstruction surgery in the left lateral decubitus position, similar to what was described by Malham and colleagues.[6] With the assistance of a vascular surgeon, using an incision above the inguinal ligament anterior to the anterior superior iliac spine on the right side, a retroperitoneal approach was taken to the L5–S1 disc space.[6,13,16] The ability to mobilize the left common iliac vein was a limitation due to prior inflammation and scarring associated with pseudoarthrosis caused by the TLIF cage,

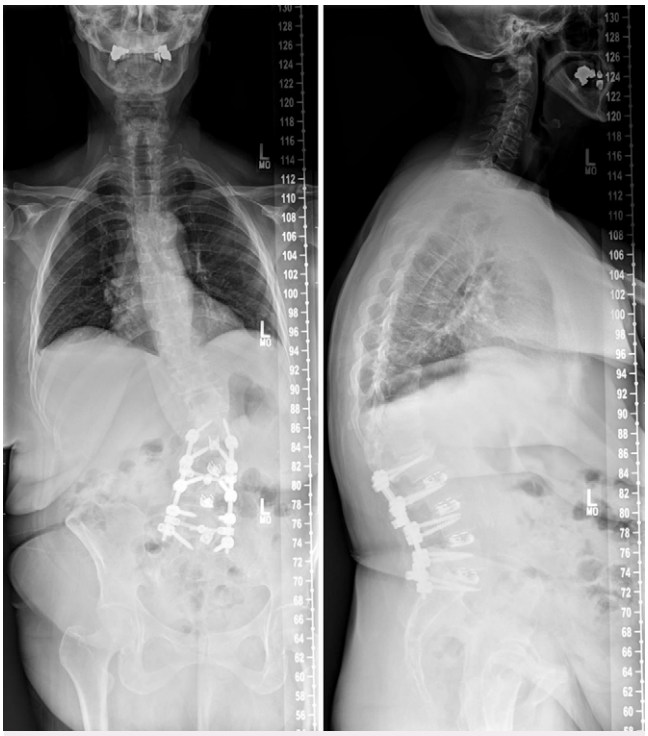

FIG. 1. Anteroposterior (**left**) and lateral (**right**) scoliosis radiographs obtained on presentation showing prior L2–S1 fusion, proximal junctional kyphosis, and coronal scoliotic deformity.

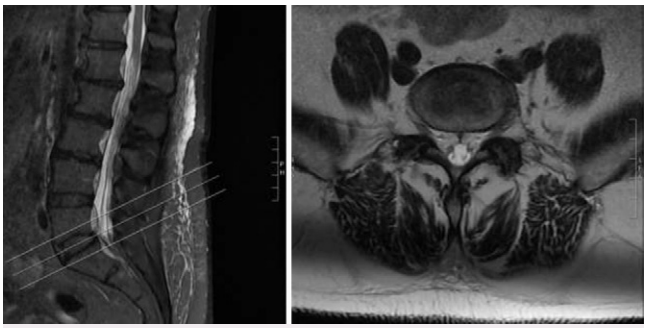

FIG. 2. Preoperative magnetic resonance images of the lumbar spine at L5–S1 level showing the vascular anatomy.

which was originally placed toward the left side. However, cauterization and mobilization of the middle sacral vessel exposed a safe working corridor over the midline of the L5–S1 disc space, confirmed with fluoroscopy. Retractors were placed in a standard fashion, and the discectomy was completed. Care was taken to note the right iliac vein, which was gravity dependent and had a propensity for falling into the operative corridor. The previous interbody cage, which was found to be highly mobile, was removed in one piece. Of note, we did encounter metallosis in the area secondary to the pseudoarthrosis. Aerobic, anaerobic, and fungal cultures of the implant were all negative. A new, appropriately sized hyperlordotic titanium cage with autograft and allograft was placed with a single retaining screw.

With the patient in the same position on the table, we then performed a standard lateral lumbar interbody fusion (LLIF) via transpsoas approach at L1–2 to address the deformity proximal to the prior construct. Lastly, the patient was placed prone on the Jackson table to correct her scoliosis and maximize LL, verified using intraoperative fluoroscopy. We subsequently removed all prior instrumentation and placed new posterior spinal instrumentation from T10 to S1 as well as S2 alar-iliac screws to achieve rigid circumferential fusion and reduce the chances of repeated nonunion. The first stage of the surgery was completed in 2.5 hours, which included anterior exposure and closure. Blood lost during this stage was 100 mL, and the total length of hospital stay was 5 days.

There were no complications intraoperatively or in the immediate postoperative period. The patient did very well, with complete resolution of her lower extremity symptoms and significant improvement in back pain. At the 1-year follow-up clinic visit, she was pain-free, did not use any pain medications, had resumed her daily routine, and could walk without the aid of any assistive devices. At the 6-month postoperative interval, there was evidence of intact hardware, correction of spinal deformity, and satisfactory fusion on radiographs (Fig. 3 and Table 1). Her spinopelvic parameters at the 1-year follow-up were LL 49°, PM 11°, PT 28°, SS 30°, and C7-SVA of 2 cm. The Cobb angle in the coronal plane was 4°.

Discussion

Observations

Over the last two decades, ALIF has been consistently gaining popularity among spine surgeons and has been shown to lead to significant indirect decompression, comparable or even better patient outcomes, and faster return to mobility and function when compared to posterior approaches.[4,17] The use of LALIF, a modification of the ALIF approach, has shown promising results, especially in obese patients

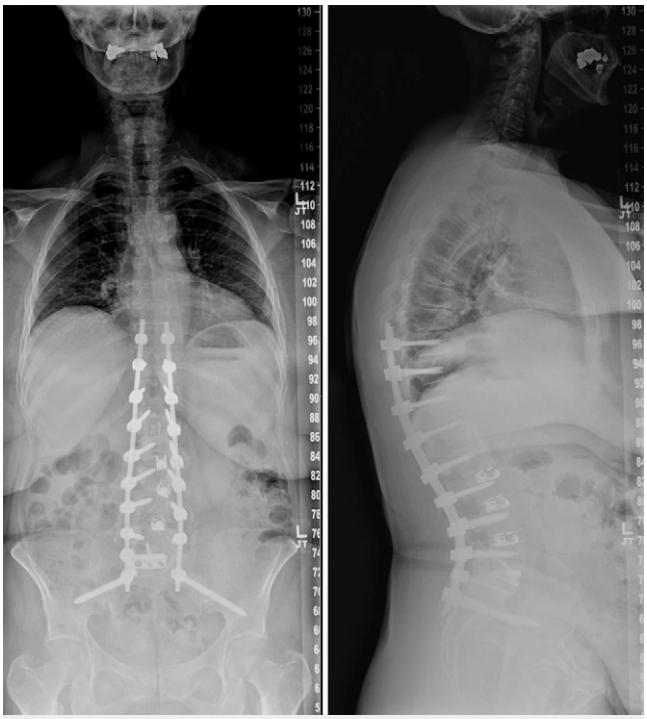

FIG 3. Anteroposterior (**left**) and lateral (**right**) scoliosis radiographs after LALIF at L5–S1, LLIF at L1–2, and revision of instrumentation with extension from T10 to the pelvis.

or patients with previous abdominal surgery.[6] The lateral patient positioning facilitates exposure by taking advantage of gravity to retract abdominal contents away from the surgical site.[6,7] There is evidence in the literature that using the anterior-lateral corridor to the spine results in less pain, better cosmesis, reduced postoperative ileus, and similar deformity correction and outcomes compared to surgery in the supine position.[4,6,9,10] From a technical perspective, LALIF offers all the benefits of an anterior approach to the spine, even in the presence of posterior instrumentation.[1,2,4,5,14,15,18]

As demonstrated by our case, LALIF can also be used for removal of a previously implanted interbody cage in case of pseudoarthrosis. The LALIF technique can provide a safe passage by avoiding scar tissue from prior posterior surgery and potential complications associated with revision spine surgery via a posterior approach.[1] Although combined ALIF and LLIF have been described in supine position, it may still require turning the patient to the prone position for posterior instrumentation to achieve a circumferential fusion.[19] LALIF increases operating room efficiency by facilitating single-position surgery, especially when fusion at multiple lumbar levels is required.[6,7,9,10,19] It also enables direct visualization of neural, visceral, and vascular structures, which makes it safer compared to oblique and lateral approaches. Posterior instrumentation, if required, can also be achieved in the same setting, thus reducing operative and anesthesia time, operating room service use, and the risks involved with repositioning an anesthetized patient with a potentially unstable spine.[6,8–10] Similar to other reports, we planned to instrument down to the pelvis with the use of the Mazor X Surgical Robot. This, along with surgeon comfort, was the reasoning behind performing the instrumentation in prone position in this case.[6]

TABLE 1. Comparison of pre- and postoperative spino-pelvic parameters

Parameter	Preop	1-yr Postop
C7-sagittal vertical axis	+6 cm	+2 cm
PT	32°	28°
Pelvic incidence	55°	60°
LL (T12–S1)	55°	49°
PM	19°	11°
SS	23°	30°
Coronal Cobb angle	22°	4°

Lessons

One limitation that we have often faced is mobilization of the great vessels, especially the bilateral iliac veins. Vascular injury is an important and potentially dangerous complication reported in anterior lumbar spine approaches, occurring in 2%–24% patients.[1,4,13,15,16,18,20] Specific attention needs to be paid to the vascular anatomy, particularly the sacral veins, which may need to be ligated and divided as has been well described.[1,11,12,16,20] At first, surgeons may not be familiar with performing ALIF in the lateral position, but for vascular and neurosurgeons, who work frequently as a team, these challenges can be overcome, providing LALIF as a safe, effective, and potentially advantageous alternative to standard ALIF surgery in appropriate cases.[6,15,16,19]

Revision of a prior failed L2–S1 fusion construct with pseudarthrosis at L5–S1 after TLIF with LALIF at L5–S1 and LLIF at L1–2 is feasible and was performed in this case without complications and with a favorable 1-year result. Single-position anterior column reconstruction may be considered as a potentially advantageous technique in appropriately selected cases to facilitate operative efficacy and efficiency.

References

1. Berjano P, Zanirato A, Langella F, et al. Anterior lumbar interbody fusion (ALIF) L5-S1 with overpowering of posterior lumbosacral instrumentation and fusion mass: a reliable solution in revision spine surgery. *Eur Spine J.* 2021;30(8):2323–2332.
2. Ploumis A, Wu C, Mehbod A, et al. Revision of transforaminal lumbar interbody fusion using anterior lumbar interbody fusion: a biomechanical study in nonosteoporotic bone. *J Neurosurg Spine.* 2010;12(1):82–87.
3. Lee SH, Kang BU, Jeon SH, et al. Revision surgery of the lumbar spine: anterior lumbar interbody fusion followed by percutaneous pedicle screw fixation. *J Neurosurg Spine.* 2006;5(3):228–233.
4. Bassani R, Morselli C, Querenghi AM, Nuara A, Sconfienza LM, Peretti GM. Functional and radiological outcome of anterior retroperitoneal versus posterior transforaminal interbody fusion in the management of single-level lumbar degenerative disease. *Neurosurg Focus.* 2020;49(3):E2.
5. Kadam A, Wigner N, Saville P, Arlet V. Overpowering posterior lumbar instrumentation and fusion with hyperlordotic anterior lumbar interbody cages followed by posterior revision: a preliminary feasibility study. *J Neurosurg Spine.* 2017;27(6):650–660.
6. Malham GM, Wagner TP, Claydon MH. Anterior lumbar interbody fusion in a lateral decubitus position: technique and outcomes in obese patients. *J Spine Surg.* 2019;5(4):433–442.

7. Xi Z, Burch S, Mummaneni PV, et al. Supine anterior lumbar interbody fusion versus lateral position oblique lumbar interbody fusion at L5-S1: a comparison of two approaches to the lumbosacral junction. *J Clin Neurosci*. 2020;82(Pt A):134–140.
8. Virk S, Iyer S, Ellozy S, Qureshi S. Safety profile, surgical technique, and early clinical results for simultaneous lateral lumbar interbody fusion and anterior lumbar interbody fusion in a lateral position. *Clin Spine Surg.* 2021;34(2):E92–E99.
9. Ashayeri K, Leon C, Tigchelaar S, et al. Single position lateral decubitus anterior lumbar interbody fusion (ALIF) and posterior fusion reduces complications and improves perioperative outcomes compared with traditional anterior-posterior lumbar fusion. *Spine J.* 2022;22:419–428.
10. Thomas JA, Thomason CIM, Braly BA, Menezes CM. Rate of failure of indirect decompression in lateral single-position surgery: clinical results. *Neurosurg Focus.* 2020;49(3):E5.
11. Chung NS, Jeon CH, Lee HD, Kweon HJ. Preoperative evaluation of left common iliac vein in oblique lateral interbody fusion at L5-S1. *Eur Spine J.* 2017;26(11):2797–2803.
12. Kim JS, Sharma SB. How I do it? Oblique lumbar interbody fusion at L5S1(OLIF51). *Acta Neurochir (Wien).* 2019;161(6):1079–1083.
13. Woods KR, Billys JB, Hynes RA. Technical description of oblique lateral interbody fusion at L1-L5 (OLIF25) and at L5-S1 (OLIF51) and evaluation of complication and fusion rates. *Spine J.* 2017;17(4):545–553.
14. Janjua MB, Ackshota N, Arlet V. Technical consideration for TLIF cage retrieval and deformity correction with anterior interbody fusion in lumbar revision surgeries. *Spine Deform.* 2019;7(4):633–640.
15. Safaee MM, Tenorio A, Haddad AF, et al. Anterior lumbar interbody fusion with cage retrieval for the treatment of pseudarthrosis after transforaminal lumbar interbody fusion: a single-institution case series. *Oper Neurosurg (Hagerstown).* 2021;20(2):164–173.
16. Berry CA, Thawrani DP, Makhoul FR. Inclusion of L5-S1 in oblique lumbar interbody fusion-techniques and early complications-a single center experience. *Spine J.* 2021;21(3):418–429.
17. Varshneya K, Medress ZA, Jensen M, et al. Trends in anterior lumbar interbody fusion in the United States: a MarketScan study from 2007 to 2014. *Clin Spine Surg.* 2020;33(5):E226–E230.
18. Tannoury T, Kempegowda H, Haddadi K, Tannoury C. Complications associated with minimally invasive anterior to the psoas (ATP) fusion of the lumbosacral spine. *Spine (Phila Pa 1976).* 2019;44(19):E1122–E1129.
19. Farber SH, Zhou JJ, Smith MA, Porter RW, Chang SW. Supine lateral lumbar interbody fusion: cadaveric proof of principle for simultaneous anterior and lateral approaches. *World Neurosurg.* 2021;S1878-8750(21)01701-0.
20. Abed Rabbo F, Wang Z, Sunna T, et al. Long-term complications of minimally-open anterolateral interbody fusion for L5-S1. *Neurochirurgie.* 2020;66(2):85–90.

Disclosures

Dr. Chandra reported personal fees from Nuvasive Inc. outside the submitted work. Dr. Cheng reported personal fees from Nuvasive Inc., Globus Medical, Spine Wave, Notogen, SpinalCyte, Surgalign, Spine Innovations, and Cytonics outside the submitted work. Dr. Veeravagu reported personal fees from Nuvasive Inc. and Medtronic while conducting the study and personal fees from Osteocentric outside the submitted work. No other disclosures were reported.

Author Contributions

Conception and design: Haider, Chandra, Cheng, Stienen, Veeravagu. Acquisition of data: Haider, Cheng, Veeravagu. Analysis and interpretation of data: Haider, Wagner, Stienen, Veeravagu. Drafting the article: Haider, Wagner, Cheng, Veeravagu. Critically revising the article: all authors. Reviewed submitted version of manuscript: Haider, Chandra, Cheng, Stienen, Veeravagu. Approved the final version of the manuscript on behalf of all authors: Haider. Statistical analysis: Haider. Administrative/technical/material support: Haider, Chandra. Study supervision: Stienen.

Correspondence

Ghani Haider: Stanford University, Stanford, CA. ghanih@stanford.edu.