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Single-Stage Lateral Anterior-to-Psoas Interbody Fusion and Facet Screws as a Treatment for L5–S1 Adjacent Segment Disease in a Patient With a Long-Segment Construct

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Objective: Adjacent segment disease (ASD) occurs in 9% of patients with long-segment lumbar spine fusion and results from the transmission of a greater degree of stress to the segments cranial and caudal to a fused segment. The treatment of symptomatic ASD typically involves extending fusion to the involved segment. Revision and extension of posterior instrumentation bears the disadvantage of involving the exposure and modification of old hardware. Lateral interbody fusion cannot be performed at L5/S1 due to the iliac crest. Anterior lumbar interbody fusion typically still requires flipping the patient to augment the construct posteriorly. Here, we present a method to treat L5/S1 ASD using single-position anterior-to-psoas (ATP) interbody fusion combined with facet screw instrumentation.
Methods: An 80-year-old man, who had undergone L2-5 fusion 27 years ago, presented with persistent lower back pain and gait dysfunction with imaging findings of L5/S1 spondylosis and ASD. Under intraoperative computed tomography navigation, left L5/S1 ATP interbody fusion was performed with simultaneous L5/S1 percutaneous facet screw fixation.
Results: The abdominal incision was 4.0 cm and the single posterior incision was 1.5 cm long. Blood loss was lower than 10 mL, and the procedure lasted for less than 1.5 hours. The patient was discharged to rehabilitation after 3 days.
Conclusion: ATP interbody fusion enabled the placement of an interbody device with a large footprint to promote fusion and reduce the risk of subsidence and pseudoarthrosis. The combined use of interbody fusion and facet screws obviates the need to link to the previous construct.

Key Words: Anterior to psoas, Lumbar interbody fusion, Adjacent segment disease

INTRODUCTION

Lumbar spine fusion is efficacious in the treatment of a variety of conditions, including spinal instability, spondylolisthesis, and degenerative disease [1,2]. However, fusion of any spinal segments results in transmission of stress to unfused adjacent segments, the manifestation and sequelae of which are referred to as adjacent segment disease (ASD) [3]. ASD occurs in 9% of patients after long-segment lumbar fusion [4]. The most common surgical method to treat ASD is to extend the prior fusion across the affected levels [5,6]. Approaching this through a revision of posterior instrumentation has many disadvantages, including the need to expose all or part of the previous hardware construct, extensive paraspinal muscle dissection, challenges in identifying normal anatomy in the setting of prior laminectomy which translates to greater operative time, more postoperative pain, slower postoperative recovery and return to function, all of which lead to a higher risk of postoperative complications and result in greater utilization of healthcare resources. Minimally invasive (MIS) options to treat ASD have a significant advantage in this regard. The "standalone" lateral lumbar interbody fusion and anterior lumbar interbody fusion (ALIF) use an interbody with a large footprint to promote fusion across the disc space, without needing a posterior exposure. However, these approaches have anatomical limitations. ALIFs are typically limited to the L4–5 and L5–S1 disc spaces by the iliac bifurcation, and a high sacral slope can make access to the L5–S1 disc space difficult. Lateral interbody fusions are limited to the midlumbar region by the rib cage superiority and the iliac crest inferiorly [7,8]. In contrast, the anterior-to-psoas (ATP) interbody fusion allows access to nearly the entire lumbar spine, all with a small incision and large interbody footprint. Here we present the case of an 80-year-old male who underwent ATP interbody fusion with facet screw instrumentation for symptomatic L5–S1 ASD after long-segment lumbar fusion.

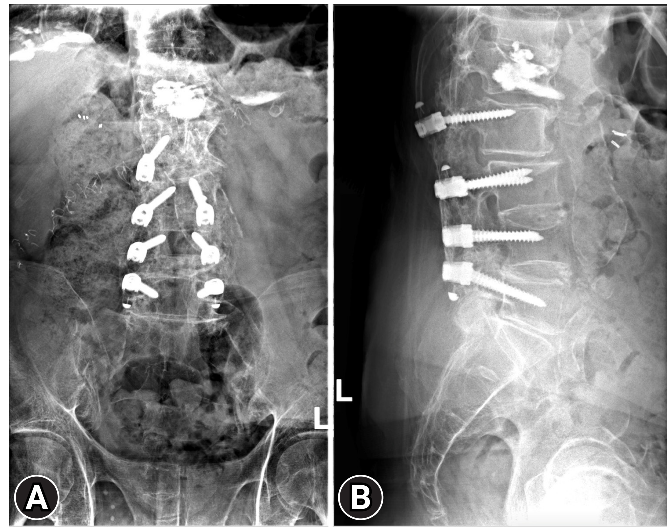

Figure 1. Preoperative x-ray showing prior L2–5 fusion with L1 intravertebral cement anteroposterior (A) and lateral views (B) in an 80-year-old male patient with L5–S1 spondylolysis and symptomatic adjacent segment disease.

MATERIALS AND METHODS

An 80-year-old male presented to our clinic for persistent lower back pain causing gait and mobility difficulty. He had a complex past medical history including chronic obstructive pulmonary disease, abdominal aortic aneurysm, prostate cancer, hypothyroidism, and osteoporosis. Twenty-seven years prior to presentation, he underwent an L2–5 laminectomy and fusion and required subsequent revision for a broken screw. Ten years prior to presentation, he had an L1 compression fracture requiring L1 intravertebral cement augmentation. Preoperative x-rays demonstrated L5–S1 ASD and spondylosis (Figure 1).

IRB approval and patient consent was obtained for the study.

RESULTS

1. Intraoperative Course

The patient, after consenting to the procedure, was positioned in the lateral decubitus position with the left side up. A left-sided exposure is favored for the ATP approach due to the relative ease of mobilizing the aorta compared to the inferior vena cava (IVC). A standard flat surgical table was used, and the patient was taped just below the axilla, below the iliac crest, and across the knees. The operative field was prepped with chlorhexidine scrub from the level of approximately T8 down to the level of the iliac crest, from the anterior abdomen at the umbilicus lateral to past midline along the back. An intraoperative computed tomography (CT) scan was obtained for navigation with placement of the navigation array in the left iliac crest. A 4-cm incision was made anterior to the iliac crest in the lateral abdomen. Each subsequent abdominal muscle layer was opened respecting the fiber orientation of the external oblique, internal oblique, and transversalis muscle, until retroperitoneal fat was reached. The retroperitoneal fat was mobilized anteriorly with endoscopic Kittners until the psoas muscle was visualized and the left common iliac artery was seen pulsating. Careful dissection was performed medial to the common iliac artery down to the promontory of S1. A table-mounted ATP retractor system from Pantheon Surgical (Georgetown, TX, USA) consisting of 4 blades to retract retroperitoneal contents was introduced and secured into place at the L5–S1 space. Fluoroscopy was then brought in to confirm the L5–S1 level (Figure 2). The discectomy was then performed with gentle distraction across the disc space using a combination of the Cobb, rasp, and pituitary to remove all disc material from the disc space. The adequacy of disc preparation was confirmed through both direct visual inspection and tactile feedback of instruments. A static interbody device measuring 40x18x12 mm with 8° of lordosis was introduced into the disc space with a pivoting action. Fluoroscopic imaging was used to confirm adequate disc preparation and interbody device placement (Figure 2). For the percutaneous L5–S1 facet screws, navigation was used to determine the location of the ideal skin incision and trajectory to navigate across the L5–S1 facet. A single 1.5-cm incision was

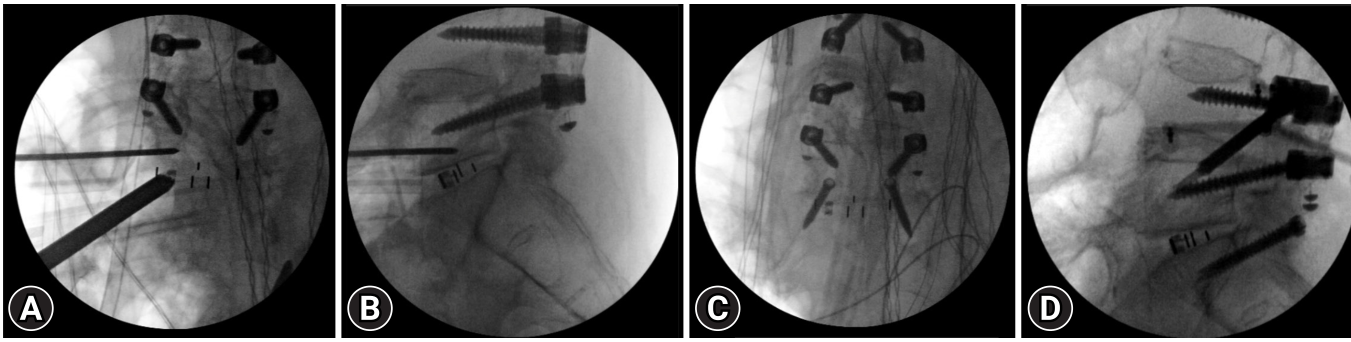

Figure 2. Intraoperative fluoroscopy demonstrating the interbody device being inserted using an O-arm navigation system in anteroposterior (A) and lateral views (B) and final images showing appropriate facet screw placement in anteroposterior (C) and lateral views (D).

made at midline through which both screws could be introduced in the appropriate trajectory. The monopolar cautery was used to dissect through the subcutaneous fat, fascia, and superficial muscle along each screw trajectory to access the starting point of the facet screws. With patient remaining in lateral position, each Trans-Facet Screw was placed under navigation, with starting point at medial edge of inferior articulating process of L5 and orientation through the facet joint towards the pedicle of S1 (Medtronic, Dublin, Ireland). The entire procedure lasted less than 1.5 hours with minimal blood loss.

Table 1. Functional independence measurement (FIM) scores at admission and discharge

FIM scores	Admission	Discharge
Eating	7	7
Grooming	5	6
Bathing	2	5
Dressing-upper body	2	6
Dressing-lower body	2	5
Toilet transfer	4	6
Toileting	1	6
Tub/shower transfer	1	6

1, total assistance needed; 7, complete independence.

2. Postoperative Course

Postoperatively, the patient reported minimal back and abdominal pain and used IV narcotics for only a few hours after surgery. On neurological exam, he had full strength in all muscle groups of the lower extremities. He was discharged to inpatient rehabilitation after 3 days for self-care retraining, adaptive equipment training, endurance, strength, home exercise program, functional mobility and transfer as related to activities of daily living. His functional independence measure scores greatly improved from admission to discharge (Table 1). He returned to clinic at 2 weeks postoperatively and continued to do well with improving back pain and no new neurological symptoms. Ten-week postoperative CTs showing facet screw placement and signs of early bony fusion across the facet joint (Figure 3).

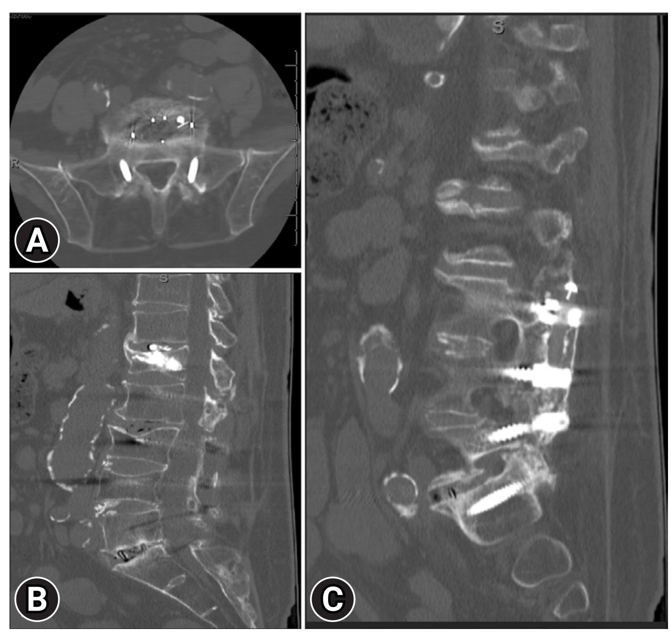

Figure 3. Ten-week postoperative computed tomography scans showing S1 pedicle screw placement in the axial (A) and sagittal views (B), as well as signs (C) of early bony fusion across the facet joint.

DISCUSSION

The ATP approach was first described in 1997 by Mayer et al. to gain access to a wider corridor in the lumbar spine and avoid some of the complications that can occur with anterior and lateral lumbar interbody fusion [9,10]. Docking onto the spine

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anterior to the psoas, instead of on the psoas, decreases rate of lumbar plexus injuries and avoids postoperative psoas pain. Further, the access corridor anterior to the psoas means neuromonitoring can usually be avoided. However, care must be taken to avoid the ureter during the approach and to prevent traction and avulsion of the iliac vessels. An approach from the left side is favored due to the presence of the aorta on the left side and the IVC on the right side. Moreover, at L5–S1, a left-sided approach may be complicated by a prominent Ilio-lumbar vein 95% of the time on the left. A decision can be made to go inside the bifurcation, lateral to the vessels, or between common iliac artery and vein. This case report is the first to describe a method of combining ATP interbody fusion with facet fixation to obtain both anterior and posterior support in treating ASD. Additionally, it highlights the unique utilization of a single incision for placement of transfacet screws, which facilitates a viable, MIS option for surgeons to perform posterior augmentation in select patients with prior long segment fusion.

A pooled meta-analysis of 503 patients comparing those who underwent a MIS transforaminal lumbar interbody fusion (TLIF) with those who underwent the ATP interbody fusion technique for the treatment of lumbar degenerative diseases revealed significantly lower subsidence levels, increased disc height, and greater foraminal cross-sectional area in the latter group [11]. There are several potential reasons for this difference. First, the ATP approach allows for placement of an interbody device with a larger cross-sectional footprint, allowing for more uniform disc height restoration across the width of the vertebral body. Second, the use of this interbody with a larger footprint more evenly distributes pressure across the adjacent end plates, decreasing risk of subsidence. A larger annulotomy can be created along the anterolateral aspect of the disc space, allowing for greater endplate cleaning.

The ATP approach to interbody fusion is a relatively newer approach compared to the TLIF and lateral interbody fusion. Utilizing the former method in combination with transfacet screws avoids the need to expose previous instrumentation or revise the long construct in order to extend the fusion to L5–S1. Some studies have reported a greater rate of interbody migration in ATP interbody fusion compared to lateral interbody fusion, although fusion rates and rate of overall complications were the same between the 2 groups [12,13]. Given that the majority of studies to this point are retrospective cohort analyses, the long-term outcomes after ATP interbody fusion still need to be analyzed.

CONCLUSION

ATP interbody fusion facilitates the placement of an interbody device with a large footprint for fusion and minimizes the risk for subsidence and pseudoarthrosis. Its combined use with percutaneous L5–S1 facet screws allows for both anterior and posterior instrumentation. This method obviates the need to expose and connect to the prior fusion construct.

NOTES

Conflict of Interest

The authors have nothing to disclose.

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REFERENCES

1. Chen WJ, Lai PL, Chen LH. Adjacent instability after instrumented lumbar fusion. Chang Gung Med J 2003;26:792–8.
2. Nakashima H, Kawakami N, Tsuji T, Ohara T, Suzuki Y, Saito T, et al. Adjacent segment disease after posterior lumbar interbody fusion: based on cases with a minimum of 10 years of follow-up. Spine (Phila Pa 1976) 2015;40:E831–41.
3. Gibson JN, Waddell G. Surgery for degenerative lumbar spondylosis: updated Cochrane Review. Spine (Phila Pa 1976) 2005;30:2312–20.
4. Okuda S, Yamashita T, Matsumoto T, Nagamoto Y, Sugiura T, Takahashi Y, et al. Adjacent segment disease after posterior lumbar interbody fusion: a case series of 1000 patients. Global Spine J 2018;8:722–7.
5. Lee JC, Kim Y, Soh JW, Shin BJ. Risk factors of adjacent segment disease requiring surgery after lumbar spinal fusion: comparison of posterior lumbar interbody fusion and posterolateral fusion. Spine (Phila Pa 1976) 2014;39:E339–45.
6. Chou D, Dekutoski M, Hermsmeyer J, Norvell DC. The treatment of lumbar adjacent segment pathology after a previous lumbar surgery: a systematic review. Spine (Phila Pa 1976) 2012;37(22 Suppl):S180–8.

7. Mobbs RJ, Phan K, Malham G, Seex K, Rao PJ. Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MI-TLIF, OLIF/ATP, LLIF and ALIF. J Spine Surg 2015;1:2–18.
8. Pawar AY, Hughes AP, Sama AA, Girardi FP, Lebl DR, Cammisa FP. A comparative study of lateral lumbar interbody fusion and posterior lumbar interbody fusion in degenerative lumbar spondylolisthesis. Asian Spine J 2015;9:668–74.
9. Mayer HM. A new microsurgical technique for minimally invasive anterior lumbar interbody fusion. Spine (Phila Pa 1976) 1997;22:691–9; discussion 700.
10. Silvestre C, Mac-Thiong JM, Hilmi R, Roussouly P. Complications and morbidities of mini-open anterior retroperitoneal lumbar interbody fusion: oblique lumbar interbody fusion in 179 patients. Asian Spine J 2012;6:89–97.
11. Zhang QY, Tan J, Huang K, Xie HQ. Minimally invasive transforaminal lumbar interbody fusion versus oblique lateral interbody fusion for lumbar degenerative disease: a meta-analysis. BMC Musculoskelet Disord 2021;22:802.
12. Lin GX, Akbary K, Kotheeranurak V, Quillo-Olvera J, Jo HJ, Yang XW, et al. Clinical and radiologic outcomes of direct versus indirect decompression with lumbar interbody fusion: a matched-pair comparison analysis. World Neurosurg 2018;119:e898–909.
13. Bhatti AU, Cesare J, Wahood W, Alvi MA, Onyedimma CE, Ghaith AK, et al. Assessing the differences in operative and patient-reported outcomes between lateral approaches for lumbar fusion: a systematic review and indirect meta-analysis. J Neurosurg Spine 2022 Apr 22:1–17. doi: 10.3171/2022.2.SPINE211164. [Epub].

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