Laparoscopic Aided Interlocking Screw Removal for Symptomatic Leg Pain after Anterior Lumbar Interbody Fusion Technique: A Case Series and Review of Literature

Michael Rogers*, Ashish Patel, Van Vallina, Rebecca Michna

Duly Health and Care, Naperville, Illinois, USA

Corresponding Author*

Michael Rogers, BS
Duly Health and Care, Naperville, Illinois,
USA E-mail: michaelrogers0210@gmail.com

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Abstract

Anterior Lumbar Interbody Fusion (ALIF) has become a standard procedure in the repertoire of a minimally invasive spine surgeon and will likely be performed more often as the incidence of adult degenerative spinal disorders in the United States increases. It is beneficial for spine surgeons to be aware of technical considerations associated with an ALIF and how to prevent complications to ensure complete surgical proficiency. This case study includes two patients who underwent standalone ALIF with a four-hole implant for lumbar degenerative disease. Both patients had full strength and were ambulatory. Both patients had persistent intermittent numbness and aching in the S1 distribution that promoted evaluation. CT scan demonstrated the left-sided screw was prominent into the left S1 foramen. The imaging correlated with the patient's symptoms and both patients elected for screw removal. In both cases, screws were removed uneventfully via a novel laparoscopic method with complete resolution of leg symptoms in both patients. Furthermore, we outline the considerations of selecting screw length in each hole when using this four-hole ALIF implant.

Keywords: Anterior lumbar interbody fusion (ALIF) • Interbody fusion • Integral screws • Interlocking screws • Laparoscopic

Introduction

The anterior approach to the spine is a popular method for spinal fusion because of its multiple benefits over traditional posterior approaches. The Anterior Lumbar Interbody Fusion (ALIF) is indicated for various pathologies such as spondylolisthesis, degenerative disc disease, pseudoarthrosis, and adjacent segment disease [1]. The implant covers a wide surface area of the disc space resulting in less subsidence [2,4], and a greater ability to restore disc height to improve foraminal dimensions and relieve stenosis [3]. Direct visualization and full access to the anterior column while avoiding the spinal canal allows for a wider annulotomy, complete discectomy, and adequate placement of bone graft leading to a high fusion rate [4]. The foremost benefit of the anterior technique may be the transection of the Anterior Longitudinal Ligament (ALL) and placement of a hyperlordotic implant at the lower lumbar segments. This may restore sagittal alignment, which is critical to obtain a satisfactory long-term outcome and reduce adjacent segment disease [5].

While the anterior approach has proven benefits, it is not without its unique complications. The most reported include visceral and vascular injuries, predominantly to the left iliac vein [6]. Other reported complications include retrograde ejaculation, erectile dysfunction, and wound infections [7]. It is well documented that assistance from an approach surgeon reduces complications associated with accessing the anterior column and plays a vital role in safety during an ALIF [7,8].

As the popularity of the technique increases, so has the development of newer ALIF implants. ALIF innovation involves implant materials, shapes, and sizes, as well as integrated screws designed to obtain anterior stability at the segmental level. This may even reduce the need for supplemental posterior fixation. The advent of stand-alone implants with integrated screw fixation has demonstrated good clinical outcomes in the appropriate setting [9]. The clinical significance of the number of screws in the implants has been assessed in a small number of studies [10-12], but intuitively, more screws and longer screws are generally desirable.

We present two ALIF cases in which a postoperative S1 neuropathy occurred due to a deep left-sided anterior sacral screw. In both cases, the prominent screw breached into the S1 foramen. They were both removed via a novel laparoscopic technique.

Case Report

Case report 1

In January 2021, a 42-year-old female presented to the clinic with chronic lower back pain. She stated that her pain had progressively worsened over time and began to impact her daily activities, including work and exercise. The patient was a long-distance runner and gradually was unable to perform. Along with her lower back pain, she endorsed difficulty primarily with flexion and pain radiating from the lower back into the bilateral buttocks. She had failed conservative treatment, including multiple injections, physical therapy, and Non-Steroidal Anti-Inflammatory Drugs (NSAIDs). She rated her pain 8 out of 10 on the Visual Analog Scale (VAS). She had no previous spine surgeries and no relevant past medical history. Physical examination showed left sided back pain, mechanical in nature, that was worse with flexion than extension. An x-ray was taken at the first clinic visit, which revealed severe degenerative disc disease at L5-S1 with retrolisthesis (Figure 1). CT revealed the same (Figure 1). MRI revealed no central stenosis, moderate bilateral foraminal stenosis with the demonstration of a vacuum disc phenomenon at L5-S1. In March 2021, the patient underwent a stand-alone ALIF (Figure 1), without complications and was discharged on POD1 with mild back pain.

At the 6-week postoperative visit, the patient stated that her back pain had resolved but endorsed worsening discomfort in the left buttock that radiated around to the lateral aspect of the hip. Her pain was well managed with gabapentin until June 2021 when it worsened. Due to her worsening symptoms, a CT scan was ordered that revealed a slightly lateral to midline implant and prominent far-left integral screw breaching into the S1 foramen resulting in displacement of the nerve root (Figure 2). In September 2021, after fusion was confirmed via CT scan, the patient elected for screw removal. Our approach surgeon elected to perform the screw removal via a novel laparoscopic technique (Figure 2). The procedure was tolerated well without intraoperative complications. A small amount of bleeding was encountered from a small venous branch which was easily controlled with a flowable hemostatic matrix. The estimated blood loss was 20cc for the entire operation, which lasted approximately two hours. The patient was discharged on POD1 without postoperative complications. At the 2-week postoperative visit, the patient endorsed the complete resolution of all radicular symptom

Case Report 2

In January 2021, a 52-year-old female presented to the clinic seeking a second opinion regarding surgical intervention for L5-S1 degenerative disc disease and retrolisthesis. Her previous records showed that she had been experiencing significantly worsening lower back pain for the past year with minimal leg pain. She also endorsed intermittent numbness in both feet. She had failed physical therapy, multiple injections, and radiofrequency ablation that only provided short-term relief. Physical examination was significant for pain with flexion, extension, and lateral bending with 5/5 strength and 2/2 sensation bilaterally. CT and MRI images were reviewed, and the diagnosis was confirmed (Figure 3). The patient elected to undergo stand-alone L5-S1 ALIF (Figure 3), in February 2021 and was discharged on POD1 after an uncomplicated hospital course.

Figure 1. Top Row: Left and Middle: AP and lateral X-ray of lumbar spine; Right: Lateral view of CT scan showing left sided degenerative disc disease at L5-S1. Middle Row: Intraoperative Fluoroscopic images (Left: lateral; Right: AP) of ALIF at L5-S1. AP view shows ALIF slightly lateral to midline. Bottom Row: 2-week postoperative lumbar x-rays (left: AP; right: lateral) of lumbar spine showing good placement of ALIF at L5-S1.

At the 2-week postoperative visit (Figure 3), the patient denied all back pain although endorsed moderate to severe leg pain with bilateral feet and right ankle numbness. Physical examination was unremarkable, with 5/5 strength and no sensory deficits noted in the bilateral lower extremities. The patient's leg pain was controlled with medication and began to diminish over the next several months until September 2021, when she stopped taking her gabapentin due to side effects. Without the medication, the severity of her leg pain increased, warranting a return to the office that prompted a CT scan to be ordered. The CT scan revealed the inferior, far left sacral screw penetrating the S1 foramen (Figure 4). After consultation with our approach surgeon, the patient underwent laparoscopic aided removal of both inferior sacral screws in December 2021 (Figure 4). Satisfactory boney fusion was noted on the preoperative CT scan, which gave reassurance that instability would not be a problem if both inferior integral screws were removed. The procedure was tolerated well without intraoperative complications. The estimated blood loss was less than 20cc for the entire operation, which lasted approximately two hours. The patient was discharged without postoperative complications and with improving radicular pain on POD1. She endorsed the complete resolution of her radicular pain by the 2-week postoperative visit.

Screw Removal - Operative Technique

The patient was positioned supine on the operative table and induced under general anesthesia. Due to the risk of vascular injury, the left and right groins were prepped and draped in the event of vascular compromise and the need for intervention. Guidewires, occlusion balloons, and fibrin sealant patches were kept close at hand to control bleeding if need be.

After local anesthesia was administered and a pneumoperitoneum was created at 15 mmHg, trocars were placed under direct visualization. A 5mm supraumbilical trocar was placed during both cases. In both cases, two additional 5mm trocars were placed: one superior to the supraumbilical trocar and another in the right medial abdomen. The placement of these trocars allowed for direct visualization of the L5-S1 interspace and surrounding structures. Meticulous dissection was performed using a vessel-sealing device, dissector sponges, and hook cautery during each case to clear the implant from its retroperitoneal tissue. In each case, the iliac veins were identified, and the left iliac retracted laterally to give adequate access to the far-left prominent sacral screws. A small pad was placed next to the left iliac vein with a long suture attached to protect it while the screwdriver was inserted. Once directly visualized, fluoroscopy was used to assess the angle of the prominent screw so that a 12mm trocar could be placed along the same angle. This allowed for unrestricted access for a screwdriver to safely remove the screw (Figure 5). Through the 12 mm trocar, the screw was removed without excessive bleeding or vascular injuries in each case. The fascia at the 12mm trocar site was closed with 0 vicryl, followed by skin closure with 4-0 vicryl.

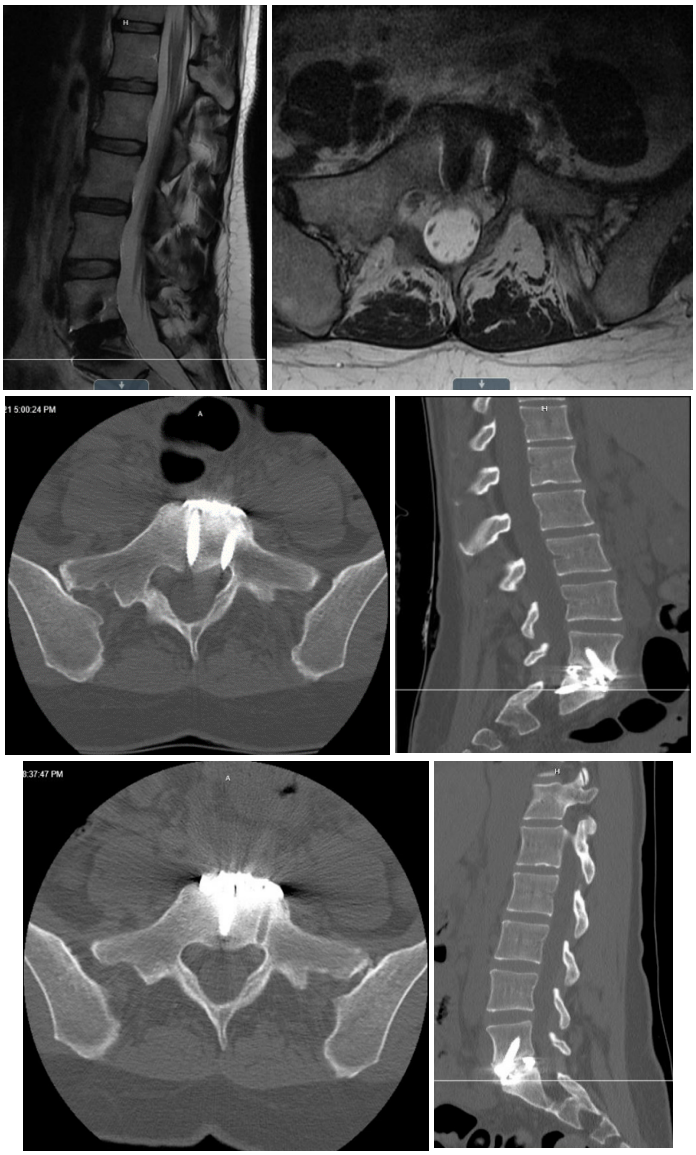

Figure 2. Top Row: Postoperative MRI (left: lateral; right: axial) showing left S1 integral screw entering the foramen and displacing nerve root. Middle and Bottom Row: Axial and sagittal CT images from Case Report 1. Middle: View of the prominent far left sacral screw breaching into the S1 foramen. Bottom: Postoperative view after sacral screw removal.

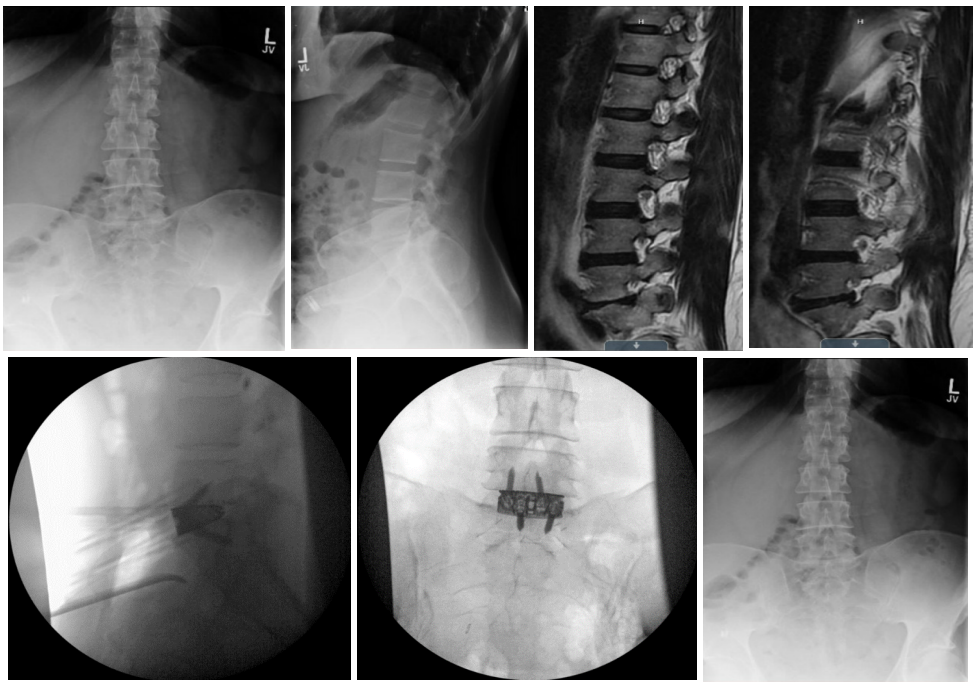

Figure 3. Top Row: Left: AP and lateral X-ray of lumbar spine showing degenerative changes at L5-S1. Right: Laterals views of MRI showing foraminal stenosis at L5-S1. Middle Row: Intraoperative Fluoroscopic images (Left: lateral; Right: AP) of ALIF at L5-S1. Bottom Row: 2-week postoperative lumbar x-rays (left: AP; right: lateral) of lumbar spine showing good placement of ALIF at L5-S1.

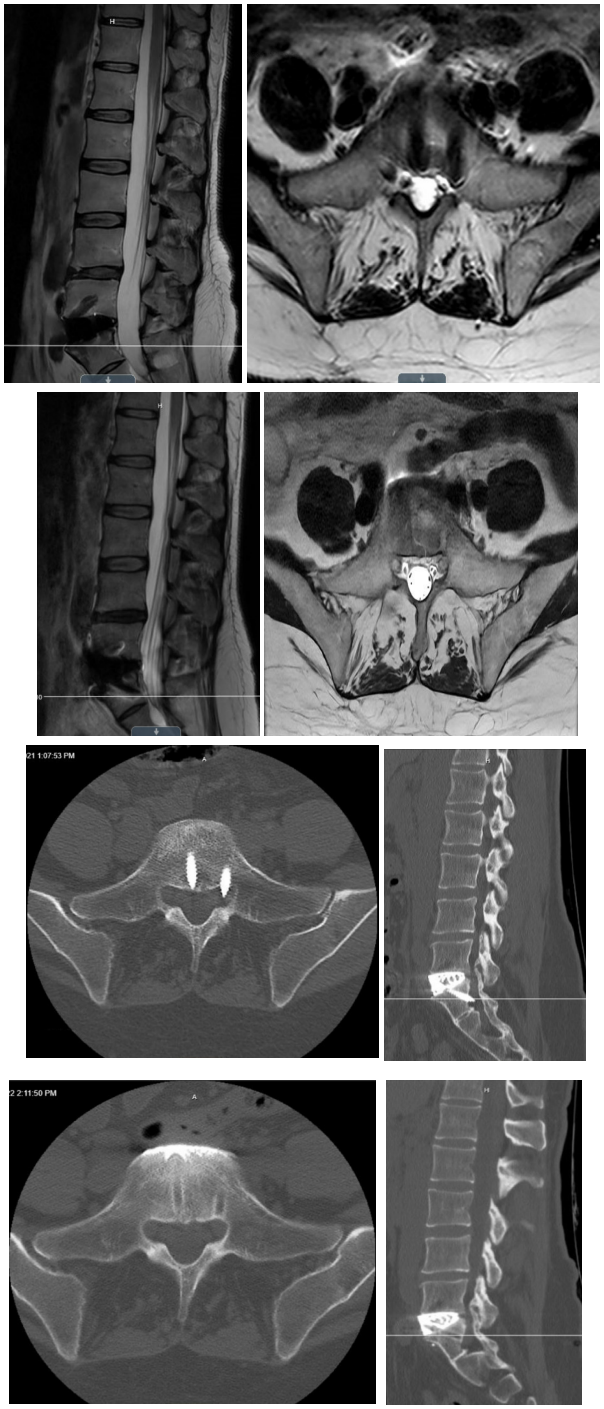

Figure 4. Top Row: Postoperative MRI (left: lateral; right: axial) showing left and possibly middle S1 integral screws entering the foramen and canal. Bottom Row: Axial and sagittal CT images from Case Report 2. Top: View of the prominent far left sacral screw breaching into the S1 foramen. Bottom: Postoperative CT image after both inferior sacral screws were removed. Satisfactory bone fusion of the facets can be noted on the postoperative sagittal CT scan.

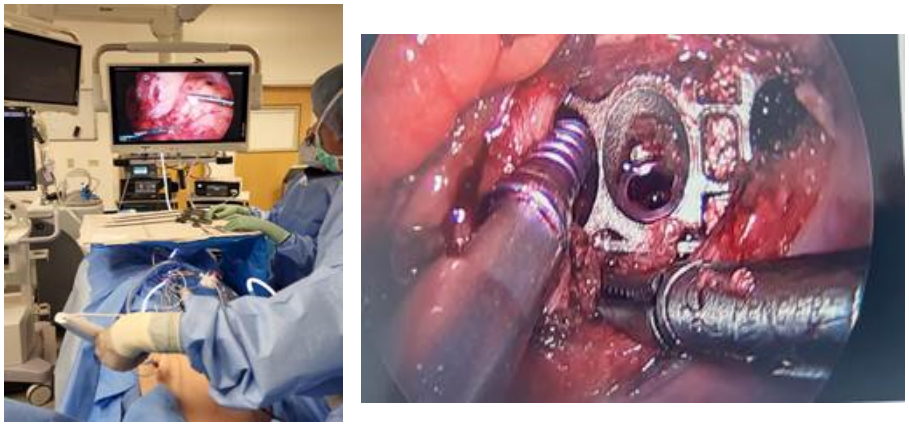

Figure 5: left: View of the surgical field and surgeon handling the laparoscopic instruments. Right: Image of integrated screw being removed via laparoscopic technique.

Discussion

Adequate segmental immobilization has been proven to lead to a higher successful fusion rate [13]. When performing the anterior technique, posterior fixation with pedicle screws would entail flipping the patient from the supine to the prone position, which could prolong operative and anesthesia time. In certain scenarios, stand-alone implants with multiple integrated screws have been proven to provide comparable segmental immobilization to posterior fixation [12]. When using these implants, there are certain nuances regarding the selection of screw size and trajectory that surgeons should be aware of.

We present two cases of patients presenting with new-onset radicular pain following ALIF. In each case, CT scans revealed a breach of the S1 foramen by the far-left sacral screw resulting in a compression neuropathy of the S1 nerve root. Patients presented in the immediate postoperative period with seemingly unremarkable postoperative symptoms that did not warrant immediate investigation. The patient in case report 1 continued to improve in the postoperative period to the point that she could walk 5-6 miles daily on the treadmill with only slight, nagging left-sided radicular pain. For this reason, imaging to investigate the source of the radicular pain was not ordered till three months after ALIF. The patient in case report 2 did not undergo investigative imaging until nine months postoperative due to her improving back pain and ability to continue daily activities and exercise, such as cycling. The predominant symptom in both cases that warranted CT scans was prolonged, unexplained radicular pain.

Misplaced integrated screws resulting in nerve root injuries have been reported one time in the literature to our knowledge [14]. Two cases of patients presenting with S1 radiculopathy following a stand-alone ALIF. The cause of the radicular pain in both cases was an integrated screw that penetrated the dorsal aspect of the S1 cortical margin of the vertebra into the foramen, compressing the S1 nerve root. An excessively lateral placed integrated screw due to a lateral implant and an integrated screw placed in the lateral screw hole were the causes in their cases. Similar to our findings, their patients presented with postoperative S1 radicular symptoms for a prolonged period of time before imaging studies were obtained. A posterior approach for screw removal was performed in both cases with direct decompression and posterior fixation. The rationale behind performing the posterior approach was the ease of repairing a dural tear in this position if the tip of the sacral screw caused a CSF leakage.

We present what is, to our knowledge, the first reports of integrated screws being removed via a laparoscopic technique. The ideal surgical approach for screw removal was scrupulously discussed, including anterior and posterior approaches, with the thought that the etiology of the patient's radicular symptoms was exclusively due to the prominent sacral screws into the S1 foramen. The posterior approach would consist of splitting the paraspinal musculature, dissecting through posterior scar tissue and retracting the nerve while a metal cutting burr would be applied. This is a feasible approach but without the need for direct decompression or posterior fixation, the posterior approach was deemed excessive and unnecessary when compared to other mini-open or minimally invasive options. Interpretation of advanced imaging gave us confidence that the screws could be removed via a laparoscopic technique, while tools for the customary anterior approach to an ALIF were kept close at hand as a backup plan. Slow, meticulous dissection of the screws from the retroperitoneal tissue was key during this approach to prevent injuries to surrounding structures. It is recommended by the authors that the patient be prepped and draped down to the iliac vessels in case of vascular compromise.

Preventing this occurrence in the future is multifactorial. The first factor that should be considered is reducing the screw length for the left-sided sacral screw hole in the NuVasive Modulus implant. The primary surgeon transitioned from an implant with 3 holes clustered in the center to a 4-hole implant with integral screws that stagger the width of the implant. In the 3-hole implant, the screws were intentionally long (20mm and 22mm) and were without issue due to their central location. The wider footprint needed for the four-screw implant resulted in the prominent far-left screw into the sacral foramen when using 20 or 22 mm screws. In addition to the increased distance from the center, the screw hole is also recessed into the implant resulting in further depth into the bone. The authors in this series have since used shorter lateral screws (17.5mm max) without the reoccurrence of this complication. Another factor is the positioning of the implant, as a midline, anteriorly placed implant would be least likely to lead to this complication.

Conclusion

Our report describes a successful laparoscopic method for ALIF screw removal in the event of a prominent screw into the sacral foramen. The predominant symptom that each patient presented with was unexplained radicular pain following ALIF. If these symptoms persist, computed tomography should be obtained to assess implant placement and integrated screw trajectories. Furthermore, utilizing shorter lateral integrated screws has not led to a reoccurrence of this complication.

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