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Treatment of Degenerative Disc Disease with Lateral Lumbar Interbody Fusion and Catalyst Bone Graft: Two High-Risk Patients with Consistent Outcomes Across Levels

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Abstract

Lateral lumbar interbody fusion (LLIF) is a relatively recent minimally invasive technique used to achieve interbody fusion with fewer complications and faster recovery. Achieving solid fusion in high-risk patients is still a challenge due to comorbidities that can impact the bone healing process. Catalyst is a nanosynthetic, silicate-substituted bone graft designed to promote bone regeneration through upregulation of endogenous bone morphogenetic protein-2 (BMP-2) and activation of dual ossification pathways, including both intramembraneous and endochondral ossification.

We report two cases of high-risk patients diagnosed with degenerative disc disease (DDD) who underwent single and multiple level LLIF using Catalyst bone graft. At 12-month follow-up, CT scans confirmed solid interbody fusion with evidence of bone bridging across the treated levels. These findings are consistent with previous evidence supporting the use of Catalyst in challenging fusion environments and the potential benefit in high-risk LLIF patients.

Keywords: lumbar interbody fusion; Nanosynthetic bone graft; Silicate-substituted calcium phosphate; Degenerative disc disease

Introduction

Lumbar interbody fusion is broadly used as a surgical treatment in patients experiencing chronic back pain with or without radiculopathy [1-3]. Conventional open approaches, including posterior lumbar interbody fusion and transforaminal lumbar interbody fusion, have demonstrated favorable success rates. However, these approaches are associated with certain limitations, such as more postoperative pain, more blood loss, and prolonged length of hospital stays [2,4,5].

Lateral lumbar interbody fusion (LLIF) is a relatively recent minimally invasive technique used to achieve interbody fusion. This approach is also described in the literature under proprietary terms, including eXtreme Lateral Interbody Fusion (XLIF, NuVasive, Inc.) and Direct Lateral Interbody Fusion (DLIF, Medtronic Sofamor Danek). Since the first description of the technique, the indications for LLIF have expanded, and the rate of LLIF procedures performed in the USA has increased [4,6]. LLIF offers superior biomechanical stability through a large footprint interbody cage with minimal to absent posterior disruption. This is important when a degenerative disc disease (DDD) diagnosis exists, as this type of surgical intervention prioritizes restoring disc height and indirect decompression while preserving posterior elements. Using a lateral retroperitoneal approach to the anterior spinal column, LLIF circumvents some of the challenges and morbidity risk of anterior or posterior lumbar interbody fusion techniques. However, LLIF is not without its unique complications [1,2,6].

We report two cases of DDD involving one- and three-level disease with distinctive radiological and comorbidities profiles, treated identically with LLIF using Catalyst bone graft.

Case Presentation

Case 1

Case 1 is a 41-year-old female who presented with complaints of increasing recurrent back pain along with residual bilateral buttock, thigh, and leg radiculopathy, with right side worse than left. Past surgical history included a prior discectomy at L4-L5 on the right side. She was noted to have scoliosis that was concave to the right from L3-L5 and concave to the left at L5-S1. She was diagnosed with DDD from L3-S1 that was worse than L4-S1, along with facet arthropathy. The greatest area of stenosis was L4-5, which was felt to be contributing to most of her symptoms.

Relevant medical co-morbidities included obesity (BMI 33) and active smoking (10 cigarettes per day).

After failing conservative treatment, a staged operation involving left-side lateral interbody fusion at L4- L5 followed by posterior spinal fusion at the same level was offered. After the patient was informed of the potential risks and benefits, the surgery was performed.

Under general anesthesia, she was positioned in the right lateral decubitus position with the left side up. Fluoroscopy was used to localize and mark the L4–L5 level. An oblique incision was made, followed by blunt dissection through the abdominal wall. The transversalis fascia was incised to access the retroperitoneal space. Continuous intraoperative electromyographic (EMG) neuromonitoring was utilized to safely traverse the muscle and access the L4–L5 disc space. Self-retaining retractors were placed to maintain exposure. An annulotomy was performed, the disc space was prepared, and a porous PEEK interbody cage (NuVasive) packed with 6.0 cc OssDsign Catalyst was inserted into the disc space.

The second stage was performed two days later, consisting of posterior spinal fusion with rigid rods and pedicle instrumentation at L4–L5 using local autograft placed in the posterolateral gutters. The estimated blood loss was minimal, no intraoperative complications, and the patient recovered well postoperatively.

Case 2

Case 2 is a 63-year-old male who presented with a significant medical history of a right below-knee amputation after frostbite, dated 34 years ago. He had complaints of increasing chronic low back pain along with bilateral buttock, thigh, and leg radiculopathy, the right side worse than the left. He was diagnosed with DDD from L2-L5 that was worse at L4-L5, along with facet arthropathy. No past surgical history. Relevant medical co-morbidities include cardiovascular and endocrine diseases, hypertension, diabetes, and a history of cancer.

After failing conservative treatment, a staged operation involving a right LLIF from L2-L5, and a posterior fusion with instrumentation spanning L2-L5 was planned. After the patient was informed of the potential risks and benefits, the patient underwent a left LLIF at L2-L5 in an identical manner as the previous case. An annulotomy was performed, the disc space was prepared, and a porous PEEK interbody cage (NuVasive) packed with 8.0 cc OssDsign Catalyst was inserted into the disc space. The L3-L4 and L2-L3 were subsequently treated in the same manner, each receiving a PEEK interbody cage packed with OssDsign Catalyst as the previous disc level.

The second stage was performed two days later, consisting of posterior spinal fusion with rigid rods and pedicle screws instrumentation from L2–L5 using local autograft placed in the posterolateral gutters. The estimated blood loss was 25 ml, no intraoperative complications, and the patient recovered well postoperatively.

Actual Outcome

Case 1: At 12-month follow-up, both flexion-extension views revealed solid bridging (Figure 1a and b) with Catalyst appearing to be consolidated with stable posterior instrumentation at L4-5.

A further CT scan confirmed the presence of bridging bone connecting adjacent vertebral bodies (Figure 2).

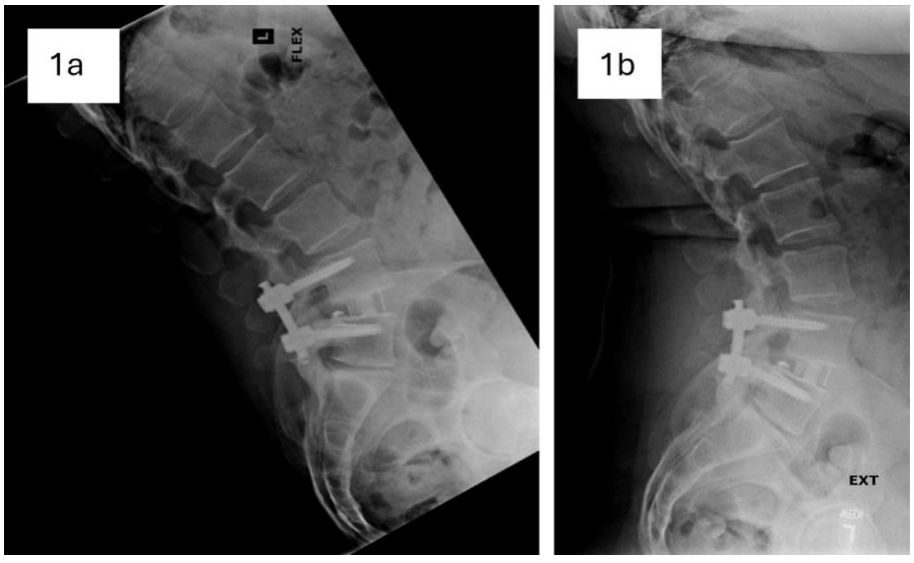

Figure 1: Flexion (a) and extension (b) X-rays at 12 months demonstrating stable posterior instrumentation at L4-L5 with satisfactory alignment and bony bridging between the vertebral bodies.

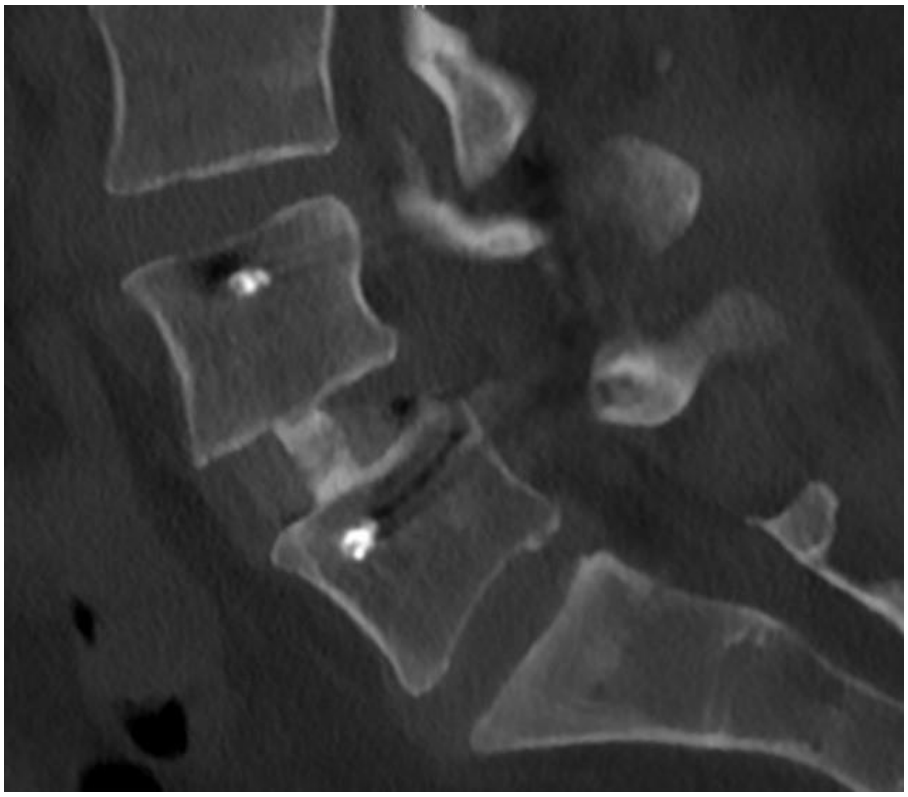

Figure 2: Sagittal computed tomography (CT) at 12-month follow-up demonstrating stable construct and stable spinal alignment with solid fusion at L4-L5.

Actual Outcome

Case 2: At 12-month follow-up, the patient's X-ray of case 2 revealed the presence of bridging bone connecting adjacent vertebral bodies at both L2-L3 and L4-L5 with Catalyst bone graft appearing to be consolidated, and stable posterior instrumentation spanning L2-5 (Figure 3a and b). The L3-L4 level fusion was not visible due to the presence of a plate.

CT scan confirmed the presence of bone bridging for all levels (Figure 4a-d).

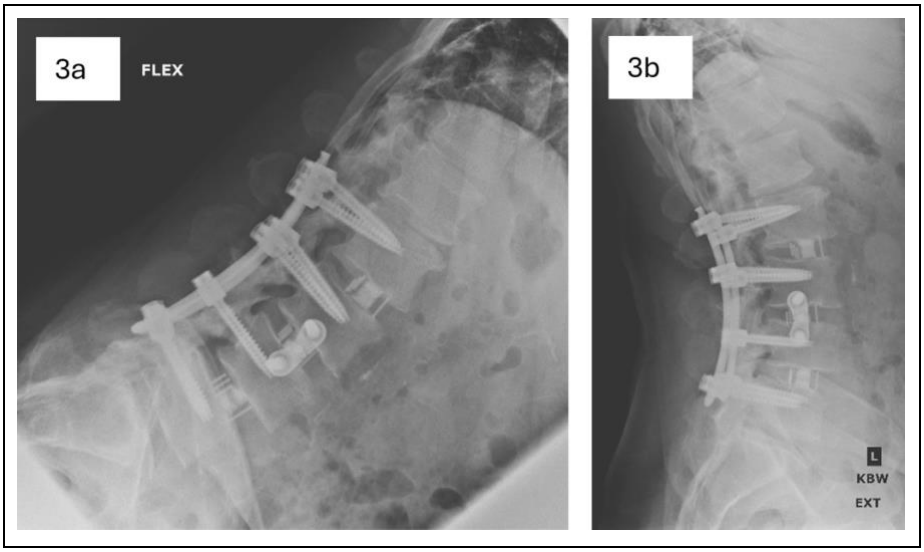

Figure 3: Flexion (a) and extension (b) X-rays at 12 months demonstrating stable posterior instrumentation at L2-L3 and L4-L5 with satisfactory alignment and presence of bridging bone.

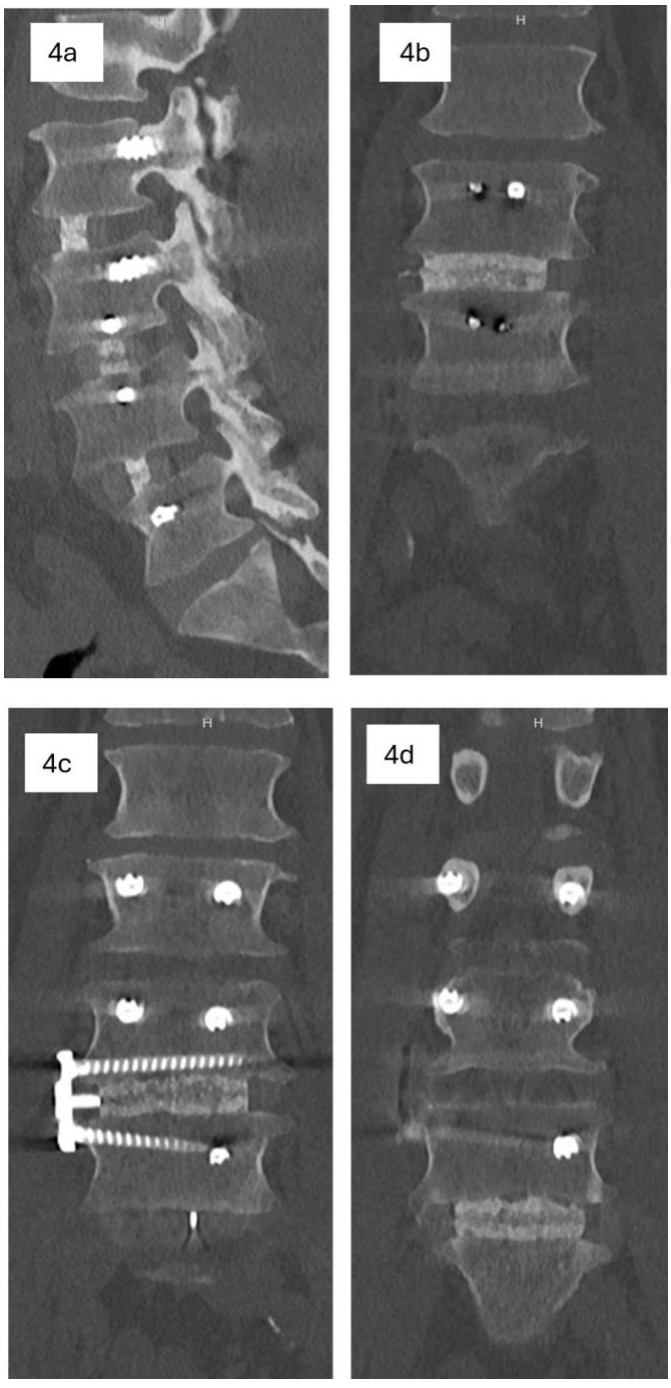

Figure 4: Complete bridging at L2-L3, L3-L4, and L4-L5 at 12-month follow-up: sagittal CT (a) and coronal CT reformations demonstrate continuous trabecular bone bridging with endplate-to-endplate bone incorporation at L2-L3 (b), L3-L4 (d), and L4-L5 (c).

Discussion

This case report describes two high-risk patients who underwent LLIF with Catalyst bone graft, both diagnosed with degenerative disc disease, with very good clinical outcomes and quick recovery at 12-month follow-up. LLIF offers several recognized advantages, including reduced soft tissue disruption, lower blood loss, shorter hospitalization, and faster recovery. Additionally, the use of larger interbody cages allows restoration of disc [7] height and indirect neural decompression, which may contribute to improved functional outcomes [1-3].

Despite the high-risk profile, both patients showed radiographic evidence of solid bone bridging as confirmed by the post-operative CT scan and flexion-extension imaging at 12 months across both single and multi-level procedures. In both cases, no intra- or post-operative complications were observed.

The favorable outcomes observed in these cases may be related, in part, to the biological properties of the bone graft material. Catalyst is a nanosynthetic, silicate-substituted bone graft that has been shown to promote bone healing through the upregulation of endogenous BMP-2 and activation of dual-pathway healing, including both intramembraneous and endochondral ossification environments in preclinical models [8-10]. Historically, bone healing promoted by bone grafts has been mainly explained by intramembranous pathway [7]. Emergent studies suggest that endochondral ossification may hold advantages over intramembrane ossification when it comes to bone healing [11,12]. Additionally, Catalyst is able to induce bone regeneration without the need to integrate exogenous bioactive proteins or growth factors, such as BMP, which may reduce potential complications associated with their use.

While Catalyst bone graft has previously shown successful outcomes in challenging multilevel XLIF cases also associated with degenerative disc disease [13,14], these cases extend the existing evidence by demonstrating reproducible fusion outcomes in a high-risk LLIF population.

Conclusion

These findings showed that Catalyst provided reliable bone healing independent of procedural complexity or number of treated levels, even in cases traditionally considered at higher risk for impaired fusion.

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