

Minimally Invasive Transforaminal Lumbar Interbody Fusion for Osteogenesis Imperfecta: A Case Report

Gabriel Gonzalez-Diaz, MD; John Muñoz, BME; Natalie Figueroa, MS;
Emil Varas-Rodríguez, MD; Karl Vega, MD; Oscar Duyos, MD

This case report describes the use of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) in a patient with osteogenesis imperfecta (OI). A 59-year-old woman with significant spinal stenosis and anterolisthesis at L4–L5 underwent MIS-TLIF due to a lack of improvement with conservative measures. Preoperative planning was key, as the patient's dual-energy X-ray absorptiometry scan revealed osteopenia. The procedure was completed without intraoperative or postoperative complications; nerve root decompression resulted in significant symptomatic improvement. At 1-year follow-up, the patient had no axial or radicular pain, full motor strength, and no evidence of cage subsidence or pedicle screw loosening. This case highlights the feasibility of MIS-TLIF in a patient with OI and underscores the importance of meticulous preoperative planning and advanced imaging techniques to ensure safety and efficacy in patients with connective tissue disorders.

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Osteogenesis imperfecta (OI) is a rare genetic disorder that affects bone and connective tissue due to defects in type I collagen production (1). The condition has a prevalence of approximately 1 in 15,000 to 20,000 live births, and disrupts the structure of the extracellular matrix, resulting in bone fragility and increased fracture risk (2,3). OI can pose surgical challenges, particularly in adult patients with OI, who often present with low bone density and skeletal deformities (4).

In the general adult population, spinal pathologies such as spondylolisthesis are common and may require surgical intervention, such as posterolateral fusion or transforaminal lumbar interbody fusion (TLIF) (5). Although some subtypes of OI are associated with a mild phenotype, adults frequently exhibit reduced bone mineral density and fracture susceptibility, which can undermine pedicle screw purchase and increase the risk of hardware complications during instrumented fusion (6).

When considering TLIF, a minimally invasive approach such as minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) has demonstrated several advantages, including reductions in tissue trauma, blood loss, and recovery time (7). To our knowledge, there are no published studies in the literature describing the use of MIS-TLIF in this specific patient population. This case report describes the use of MIS-TLIF in a 59-year-old woman with OI.

Case Report

A 59-year-old woman with a medical history significant for type I OI and hypothyroidism presented with complaints of chronic low back pain and right greater than left radicular leg pain in the L5 dermatomal distribution. The patient's pain was affecting her quality of life and activities of daily living, and her walking tolerance was severely diminished. The patient failed

extensive conservative management, including physical therapy, pain medications, and epidural steroid injections.

Upon further evaluation, lumbar magnetic resonance imaging confirmed moderate-to-severe bilateral lateral recess and foraminal stenosis, severe degenerative disc disease with loss of disc height, and grade 1 anterolisthesis at L4–L5 (Figure 1). The patient also exhibited a vacuum disc phenomenon, and computed tomography (CT) imaging revealed top-down stenosis at both foramina. Given the severity of her symptoms and the progression of her condition, surgical intervention in the form of MIS-TLIF was recommended.

After 6 months of unsuccessful nonoperative management, the patient elected to undergo spine surgery. The preoperative workup included CT imaging, dynamic X-rays, dual-energy X-ray absorptiometry (DEXA) scan, serum vitamin D3 levels, and electromyography with nerve conduction studies (EMG-NCS). The patient's serum 25-hydroxyvitamin D demonstrated a concentration of 77.4 ng/mL, which fell within the normal reference range of 30–100 ng/mL. The DEXA scan demonstrated a total lumbar spine T-score of –1.4, consistent with osteopenia (Figure 2). Aside from the previously described imaging abnormalities, the remaining evaluated studies were within normal limits.

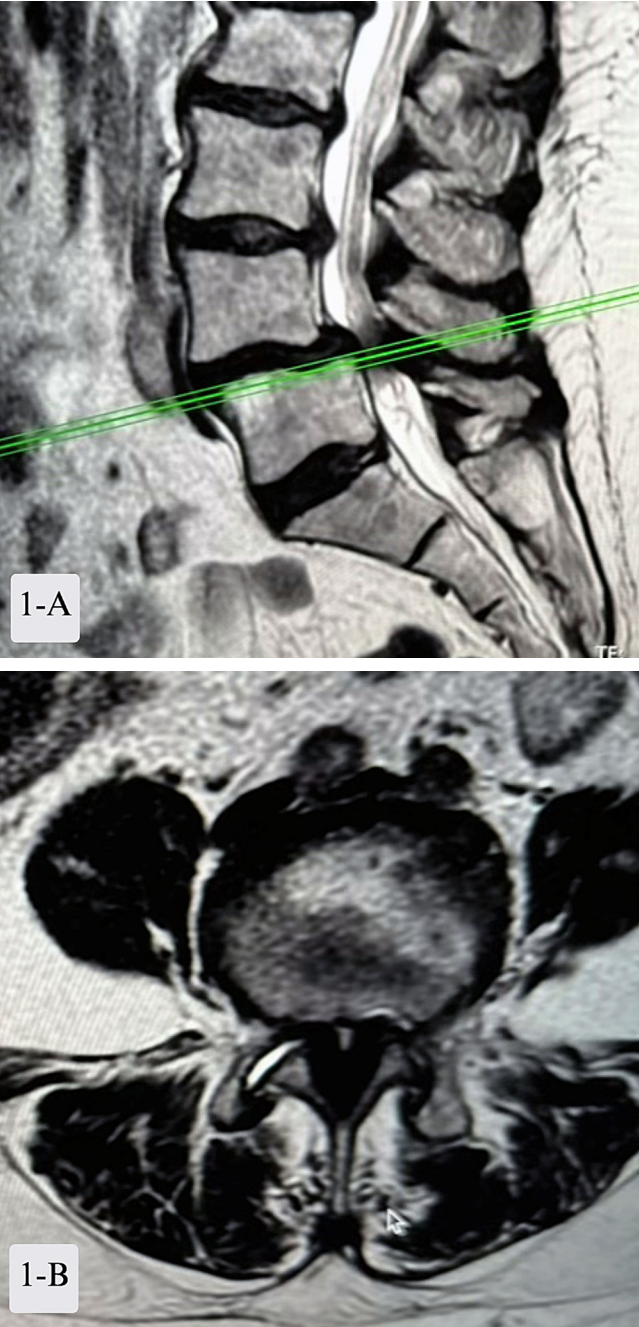
During the procedure, decompression was performed to relieve the affected nerve roots, and no dural tears or complications occurred. Stereotactic navigation with the O-arm O2 Imaging

Ponce Health Sciences University, Department of Orthopedic Surgery, Ponce, Puerto Rico

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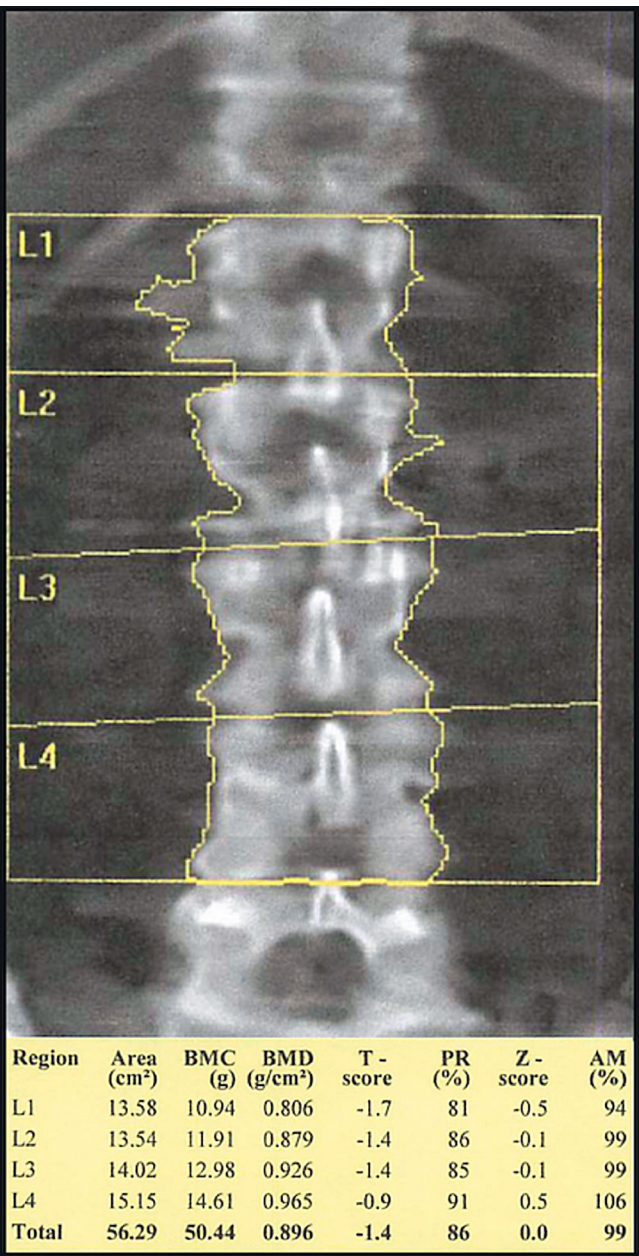
Address correspondence to: Gabriel Gonzalez-Diaz, MD, Ponce Health Sciences University, Department of Orthopedic Surgery, Ponce, Puerto Rico. Email: ggonzalez21@stu.psm.edu

Figure 1. Magnetic Resonance Imaging. 1-A: Sagittal magnetic resonance image showing evidence for anterolisthesis and degenerative disc disease. 1-B: Axial magnetic resonance image showing evidence of bilateral lateral recess stenosis and foraminal stenosis.



System and Mazor X robotic guidance platform facilitated precise placement of pedicle screws and the interbody cage (Figure 3), while neuromonitoring confirmed the safety of screw placement throughout the procedure. Adequate fixation was achieved with stable hardware placement and no intraoperative complications.

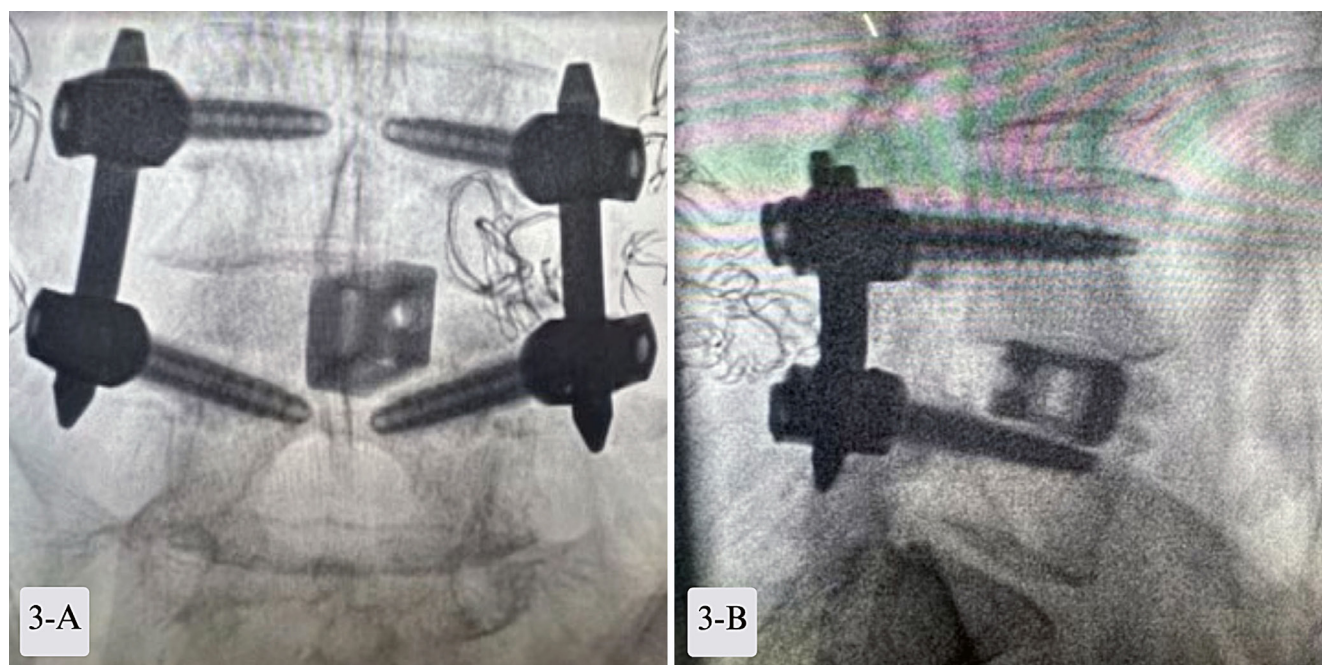
Figure 2. Preoperative DEXA scan summarizing BMD data for the lumbar spine (L1–L4).



Abbreviations: AM, age-matched; BMC, bone mineral content; BMD, bone mineral density; DEXA, dual-energy X-ray absorptiometry; L1–L4, lumbar vertebrae 1–4; PR, peak reference.

Postoperatively, the patient reported immediate pain relief. There were no complications, and the patient was discharged 2 days after surgery. At her 1-year follow-up, the patient had no axial pain, complete resolution of radicular symptoms, and 5/5 motor strength in her lower extremities. Repeat imaging demonstrated stable hardware with no signs of pedicle screw loosening, cage subsidence, or nonunion, despite the patient’s underlying bone fragility.

Figure 3. Hardware Radiographs. 3-A and 3-B: Anteroposterior and lateral X-rays, respectively, displaying the cage implant and hardware placement.



Discussion

Although we recognize that type I OI generally features a milder clinical phenotype than other subtypes, the successful execution of MIS-TLIF in this patient presents a significant clinical achievement, given the inherent complexities of managing spinal pathologies in this population. Patients with OI, characterized by fragile bone and connective tissue due to type I collagen defects, have an increased risk of surgical complications, particularly related to bone quality (4,6). This case highlights the importance of meticulous preoperative planning, including the use of advanced imaging techniques and individualized surgical strategies, to address the challenges posed by osteopenia and spinal deformities.

Although MIS-TLIF has proven advantages over traditional open procedures, literature on its use in patients with OI remains limited, making additional reports in this population clinically relevant. The patient's satisfactory outcome, with no intraoperative or postoperative complications, suggests MIS-TLIF as an alternative in managing complex spinal pathologies in this patient population. Importantly, the use of robotic assistance and intraoperative imaging allowed for precise placement of instrumentation despite the patient's compromised bone quality, facilitating stability without hardware complications.

This case contributes to the growing body of evidence supporting MIS-TLIF as a viable option for patients with degenerative spine conditions and underlying genetic disorders such as OI. Given the limited data on surgical outcomes in patients with OI, this case underscores the need for further research into minimally invasive techniques tailored to this population. In this patient with significant

lumbar spinal stenosis and anterolisthesis, a multidisciplinary approach that included thorough preoperative assessments (DEXA scan, CT imaging, and EMG-NCS) and intraoperative technology was used to mitigate the risks associated with bone fragility.

Ultimately, this case provides a valuable reference point for spine surgeons considering MIS-TLIF for patients with OI. While the positive outcome of this surgery supports the use of MIS techniques in patients with decreased bone density, larger studies are needed to evaluate the long-term efficacy and safety of these procedures in patients with OI.

Resumen

Este caso describe el uso de la fusión intercorporal lumbar transforaminal mínimamente invasiva (MIS-TLIF, por sus siglas en inglés) en un paciente con osteogénesis imperfecta (OI). Una mujer de 59 años con estenosis espinal significativa y anterolistesis en L4-L5 se sometió a MIS-TLIF debido a la falta de mejora con medidas conservadoras. La planificación preoperatoria fue clave, ya que la densitometría ósea reveló osteopenia. El procedimiento fue exitoso sin complicaciones intraoperatorias ni posoperatorias y la descompresión de la raíz nerviosa resultó en alivio y mejoría sintomática. En el seguimiento de un año, la paciente se presentó sin dolor axial o radicular, con fuerza motora completa y sin evidencia de hundimiento de la caja o aflojamiento de los tornillos pediculares. Este caso subraya la ejecución exitosa de MIS-TLIF en OI, enfatizando la importancia de una planificación meticulosa y el uso de imágenes avanzadas para garantizar la seguridad y la eficacia en pacientes con defectos de colágeno.

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