Intradiscal Osteotomy and Bilateral Expandable Transforaminal Interbody Fusion Cages for Iatrogenic Kyphotic Deformity: A Technical Report

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Abstract

Objectives Expandable transforaminal interbody fusion (TLIF) devices have been developed to introduce more segmental lordosis through a narrow operative corridor, but there are concerns about the degree of achievable correction with a small graft footprint. In this report, we describe the technical nuances associated with placing bilateral expandable cages for correction of iatrogenic deformity.

Materials and Methods A 60-year-old female with symptomatic global sagittal malalignment and a severe lumbar kyphotic deformity after five prior lumbar surgeries presented to our institution. We performed multilevel posterior column osteotomies, a L3–4 intradiscal osteotomy, and placed bilateral lordotic expandable TLIF cages at the level of maximum segmental kyphosis.

Results We achieve a 21-degree correction of the patient's focal kyphotic deformity and restoration of the patient global sagittal alignment.

Conclusion This case demonstrates both the feasibility and utility of placing bilateral expandable TLIF cages at a single disc space in the setting of severe focal sagittal malalignment. This technique expands the implant footprint and, when coupled with an intradiscal osteotomy, allows for a significant restoration of segmental lordosis.

Keywords
- transforaminal
- lumbar
- interbody
- fusion
- expandable
- kyphosis
- deformity

Introduction

Expandable transforaminal interbody fusion (TLIF) instrumentation has been developed to maximize the deployable graft size, while decreasing the risk of endplate, nerve root, and dural injuries associated with a larger graft size and collapsed disc space. Restoration of lumbar lordosis and global sagittal alignment is associated with improvements in postoperative patient reported outcomes.[1,2] There is equivocal evidence regarding the degree to which a single expandable cage can restore segmental lordosis.[3,4] There are also conflicting reports regarding the rate of cage subsidence and endplate violation, which may be dependent upon the degree to which the posterior column is released.[3,4] In this technical description, we correct an iatrogenic kyphotic deformity of the lumbar spine associated with global sagittal malalignment with an intradiscal osteotomy at the site of maximum segmental kyphosis with placement of bilateral expandable TLIF cages.

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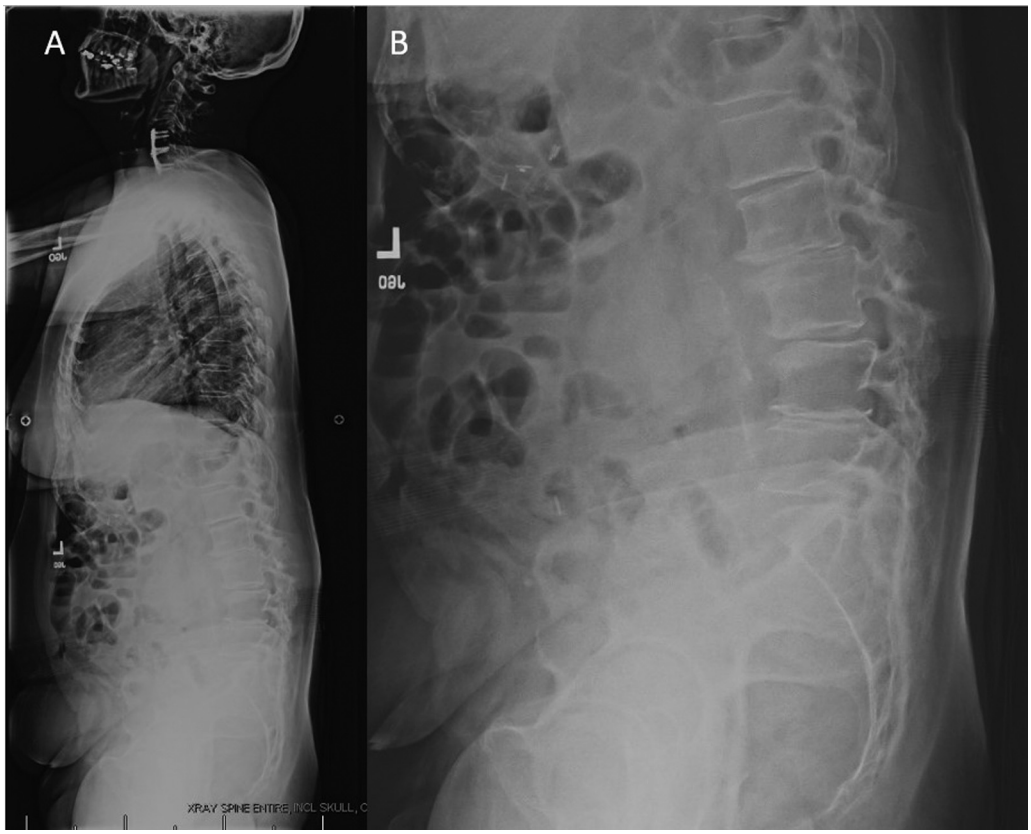

Fig. 1 (**A**) Preoperative long cassette standing films demonstrating global sagittal malalignment (**B**) Focal view of the lumbar spine demonstrating maximum segmental kyphosis at L3–4.

Case Report

A 60-year-old female smoker presented to our institution after seven previous spine surgeries at outside institutions and five prior abdominal surgeries, limiting options for an anterior approach. She complained of back pain, bilateral radicular pain, and required a wheelchair for long distances. Her preoperative sagittal standing long cassette films (►**Fig. 1**) demonstrated a 10-cm C7 sagittal vertical axis (SVA) and 2 degrees of lumbar kyphosis with maximum segmental kyphosis at L3–4 (19 degrees).

After smoking cessation therapy, the patient was brought to the operative theater for placement of posterior instrumentation from L1 to the pelvis. The patient had a solid fusion from L4–S1 from prior surgery. Schwab grade II osteotomies were performed from L2–S1. At L3–4, we performed an intradiscal osteotomy, which included take down of the superior and inferior articulating processes, lamina, and spinous processes, osteotome-mediated removal of the posterior portion of the superior and inferior endplates, complete discectomy, and gentle release of the anterior anulus.[5] The disc space was then carefully distracted, and a 10-mm width by 28-mm length (22 mm while expanded) expandable cages with 15 degrees of lordosis were inserted in a transforaminal trajectory simultaneously under fluoroscopic guidance (►**Fig. 2**). Both cages were expanded to 16 mm simultaneously after appropriate symmetrical placement was confirmed. Compression was then applied across the disc space to close the osteotomy.

At 6-week follow-up, the patient's radiculopathy had completely resolved. A comprehensive assessment of our patients pre- and postoperative radiographic alignment can be found in ►**Table 1**. Postoperative plain films at 6 weeks demonstrated a C7 SVA of 4 cm. There was a 16-degree restoration of lumbar lordosis. There was a 21-degree lordotic correction of her L3–4 segmental kyphosis (►**Fig. 3**). There was no evidence of graft subsidence on follow-up imaging.

Discussion

There are conflicting reports in the literature regarding the degree to which expandable TLIF cages can add segmental lordosis, but many studies have reaffirmed their ability to increase both disc and foraminal height.[3–7] The vast majority of this evidence comes from surgeons using minimally invasive techniques or treating 1 to 2 level degenerative pathology. Some surgeons argue that the insertion of a collapsed interbody spacer reduces the damage to the endplates, while other surgeons argue that the powerful expansion mechanisms can damage the endplates themselves.[8] The expandable cage system used in our technique generates a maximum of 2.26 Newton meters of torque through the handle as it expands. It is likely that the subsidence rates associated with expandable TLIF cages depend on the degree to which the cage is expanded and whether or not posterior column osteotomies are performed. Indeed, expandable TLIF

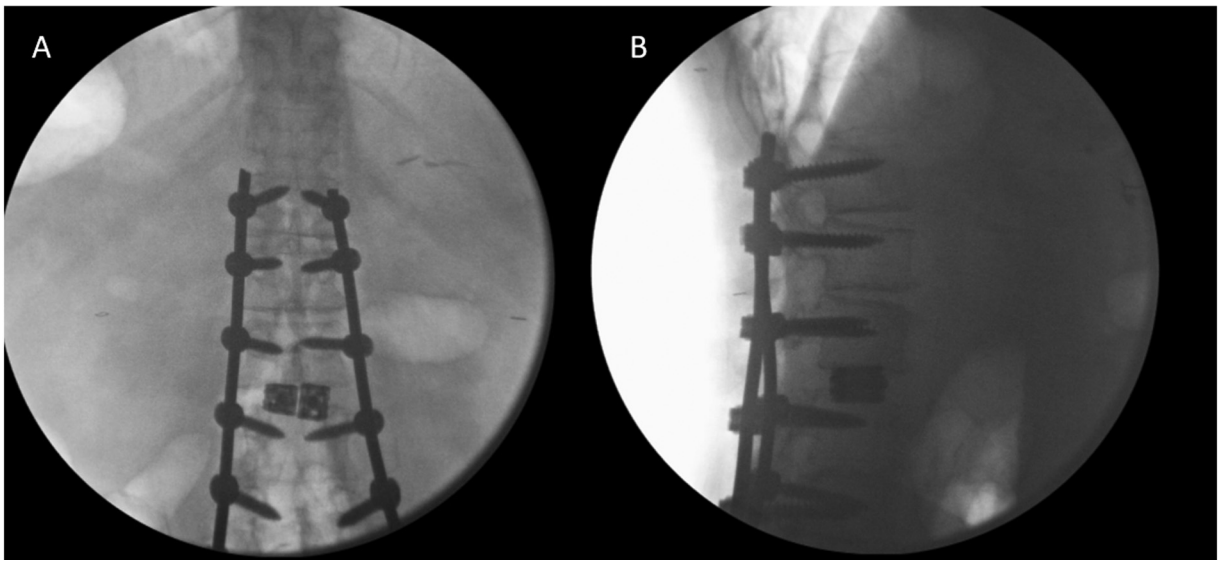

Fig. 2 (**A**) Anteroposterior and (**B**) lateral intraoperative radiographs demonstrating symmetric bilateral placement of expandable cages at L3–4 with a corresponding increase in disc space height and segmental lordosis.

Table 1 Pre- and postoperative radiographic alignment

	C7 SVA (cm)	TPA	PI	LL	PI-LL	PT	TK
Preoperative	10	33	59	–2	61	36	13
Postoperative	4	25	59	14	45	32	15

Abbreviations: C7 SVA, sagittal vertical axis (cm); LL, lumbar lordosis; PI, pelvic incidence; PT, pelvic tilt; TK, thoracic kyphosis; TPA, T1 pelvic angle.

Fig. 3 (**A**) Anteroposterior and (**B**) lateral 6 weeks postoperative long cassette standing films demonstrating restoration of global sagittal alignment.

cages are associated with a 5.6 times higher rate of subsidence in those patients without bilateral posterior column osteotomy.[4]

In our case, we performed an intradiscal osteotomy, thus it was critical to place the interbody spacers anteriorly, so as to maximize the segmental lordosis when the osteotomy was compressed. Moreover, anterior placement takes advantage of the dense apophyseal ring. Our bilateral placement allowed us to maximize the footprint of our implants prior to simultaneous expansion, potentially reducing the focal force exerted on the endplates, and reducing the chances of endplate violation. It is critical to ensure that the endplates receiving the graft are meticulously cleaned without violation. Failure to do so may result in coronal malalignment and graft subsidence. In this case, the intradiscal osteotomy helped to reduce operating room time, blood loss, and maintained pedicle and vertebral body integrity when compared with a traditional pedicle subtraction osteotomy.

Our patient had a significant improvement in her global sagittal balance and postoperative symptoms. The increased implant footprint of the dual construct may assuage some fears deformity surgeons have regarding the use of expandable implants and subsidence. Additionally, the authors believe this technique may be useful for patients with segmental and global coronal deformity if cages are expanded in a slightly asymmetric manner. However, there is

evidence to suggest that our patients residual focal deformity, a high degree of pelvic retroversion and high spinopelvic mismatch, may lead to a higher risk of mechanical complications.[9] Indeed, the Schwab Scoliosis Research Society-based classification, the International Spine Study Group age adjusted sagittal alignment classification, and the European Global Alignment and Proportion score suggest such a nonharmonious correction may lead to suboptimal mechanical outcomes.[9–13] We suggest that since our technique achieves significant anterior column lengthening, our correction should be evaluated in a fundamentally different way from those corrections described in the aforementioned studies who included a subset of three-column osteotomies and pedicle subtraction osteotomies. The authors suggest that this should be a topic of future investigation.

Conclusion

This case demonstrates both the feasibility and utility of placing bilateral expandable TLIF cages at a single disc space in the setting of severe focal sagittal malalignment. This technique expands the implant footprint and, when coupled with an intradiscal osteotomy, allows for a significant restoration of segmental lordosis.

Authors' Contributions

All authors made substantial contributions to the conception or design of the work, drafted the work and revised it critically for important intellectual content, approved the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Conflict of Interest

None declared.

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