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Unilateral Biportal Endoscopic Transpedicular Intrabody Cage Augmentation for a Metastatic Spinal Tumor with Pathologic Fracture: A Technical Note and Case Report

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Case Report

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Abstract

Study design: Technical case report

Introduction: Metastatic spinal tumor (MST) can cause pathologic burst fractures with severe pain and neurologic compromise, often requiring circumferential decompression and anterior column reconstruction. Traditional open corpectomy is associated with substantial surgical morbidity. Transpedicular intrabody augmentation has emerged as a minimally invasive alternative; however, an endoscopic approach using UBE for oncologic anterior reconstruction has not been well described.

Clinical Presentation: A 73-year-old man with metastatic colon cancer presented with debilitating axial back pain and radiculopathy due to an L2 metastatic burst fracture. He underwent percutaneous posterior screw fixation followed by UBE-assisted transpedicular tumor resection and partial corpectomy. A transpedicular corridor was created through a unilateral laminotomy, enabling ventral tumor removal under direct endoscopic visualization. An expandable titanium cage was inserted and expanded for anterior support while preserving the posterior ligamentous complex.

Results: The procedure achieved successful circumferential decompression and rigid anterior reconstruction. Pain improved immediately, and the patient ambulated on postoperative day 1. Postoperative imaging confirmed satisfactory cage position and solid anterior reconstruction.

Conclusion: UBE-assisted transpedicular intrabody cage augmentation appears to be a feasible ultra-minimally invasive alternative to open corpectomy for selected metastatic pathologic burst fractures. It enables circumferential decompression and anterior column reconstruction with reduced morbidity, aligning with palliative care principles.

Introduction

Metastatic spinal tumors (MSTs) are an increasingly common diagnosis, affecting a significant portion of cancer patients [1]. These lesions can lead to severe axial pain, pathologic burst fractures, spinal instability, and catastrophic neurological compromise from metastatic epidural spinal cord compression (MESCC) [2, 3]. The primary goal of surgical intervention for MSTs is palliative: to provide neural decompression, achieve spinal stabilization, and relieve pain, thereby maintaining or improving the patient's quality of life (QOL). The NOMS (Neurologic, Oncologic, Mechanical, Systemic) framework provides a comprehensive guide for decision-making, often identifying a need for both decompression and stabilization [4].

Historically, achieving these goals for ventral lesions such as burst fractures required extensive open procedures, including a combined anterior-posterior approach or posterior corpectomy [5]. While effective, these operations are associated with significant surgical morbidity, including high blood loss, extensive muscle dissection, and prolonged recovery times—all of which are poorly tolerated by frail, oncologic patients [5]. To address this, minimally invasive surgery (MIS) techniques have been

developed. The concept of a posterior-only, transpedicular partial corpectomy with expandable cage placement has become a viable alternative. This "intrabody augmentation" or "vertebral body reconstruction" technique, performed through tubular retractors or under a microscope, has been recently reported for various etiologies of severe vertebral collapse, including metastatic burst fractures and osteoporotic fractures like Kummell's Disease [6, 7]. However, these MIS procedures can still be limited by a narrow "keyhole" field of view, difficulty in managing bleeding, and restrictions on instrument maneuverability for achieving thorough ventral decompression.

Recently, endoscopic spine surgery, including the Unilateral Biportal Endoscopic (UBE) technique, has demonstrated efficacy in treating various spinal pathologies. Its use in metastatic disease, however, has largely been limited to decompression procedures, as highlighted in a recent multicenter study [8]. While the feasibility of placing interbody cages for degenerative disease via UBE (e.g., UBE-TLIF) has been established [9], the application of this endoscopic principle to perform an oncologic corpectomy—involving vertebral body removal, tumor debulking, and structural intrabody cage augmentation—has not yet been reported. We present, to our knowledge, the first reported case of a metastatic pathologic burst fracture treated with UBE-assisted transpedicular corpectomy and intrabody cage augmentation.

Case Presentation

A 73-year-old man with metastatic colon cancer presented with progressive, debilitating axial back pain, bilateral radicular symptoms, and inability to ambulate. Imaging demonstrated an L2 metastatic pathologic burst fracture with epidural tumor extension causing neural element compression and mechanical instability (Figs. 1 and 2). Given the palliative goals of rapid pain relief, neural decompression, and stabilization with minimal morbidity, a posterior-only strategy was selected: percutaneous pedicle screw fixation followed by unilateral biportal endoscopic (UBE) transpedicular decompression and intrabody cage augmentation.

Under general anesthesia, the patient was positioned prone on a radiolucent table. The endoscopic stage was then performed with biportal triangulation centered on the left L2 pedicle. After initial cortical drilling just medial to the left L2 pedicle, a nerve freer was placed at the drilled site and its position was confirmed fluoroscopically (Fig. 3). A left-sided laminotomy was performed to establish the working corridor while preserving the posterior ligamentous complex (PLC) and posterior tension band. The medial margin of the left L2 pedicle was identified endoscopically, and a pediclectomy was completed while maintaining a safe boundary to protect the left L3 traversing root. Through the transpedicular corridor, the approach was advanced to the ventral aspect of the thecal sac, allowing direct endoscopic visualization and removal of ventral epidural tumor using pituitary forceps and curettes until circumferential decompression was achieved. Fluoroscopy confirmed instrument reach to the contralateral ventral margin. To ensure adequate dorsal decompression for the right L3 traversing root, contralateral decompression was additionally performed through the unilateral approach (Fig. 4). After intrabody tumor debulking and partial corpectomy, an expandable titanium cage (Excender, CG Bio, South Korea - minimum insertion height 10 mm, maximum expandable height 14 mm) was inserted into

the L2 vertebral body defect and expanded to its maximum height of 14 mm, which corresponded to the dimensions of the vertebral body defect, for anterior column support.

Postoperative imaging confirmed satisfactory cage position with anterior column reconstruction (Fig. 5). The patient experienced immediate symptom relief, ambulated on postoperative day 1, and by postoperative day 7 pain had improved markedly (NRS 1).

Discussion

We describe the first reported application of the unilateral biportal endoscopic (UBE) technique for transpedicular partial corpectomy and intrabody cage augmentation in a symptomatic metastatic burst fracture. This novel procedure resulted in immediate symptom relief and enabled ambulation on the first postoperative day, thereby supporting the palliative goals of surgery.

This case illustrates several potential technical and conceptual advantages of the UBE approach in oncologic spine surgery. First, although continuous saline irrigation may not fully maintain a clear field in highly vascular metastatic tumors, the dynamic and mobile endoscopic viewpoint may still offer an important advantage in such settings. The endoscope can be advanced beyond the pedicle into the vertebral body, positioning the lens close to the lesion. This proximity allows direct visualization of the ventral tumor and facilitates decompression despite the challenging environment. The mobility of the endoscopic view, combined with a unilateral laminectomy, also allows bilateral decompression of the neural elements while preserving the posterior ligamentous complex—an established advantage of the UBE unilateral laminectomy bilateral decompression technique [10].

Second, this approach is conceptually consistent with the oncologic principles of “separation surgery.” The goal of this concept is to create a 2–3 mm gap between the tumor and the neural elements, thereby enabling safe, high-dose stereotactic body radiotherapy (SBRT) [11, 12]. Conventional posterior laminectomy and screw fixation often fail to achieve adequate ventral decompression, limiting the safety and efficacy of adjuvant radiation. In contrast, in this case, the endoscopic transpedicular approach allowed ventral tumor removal under direct visualization. Moreover, the addition of anterior column reconstruction with an intrabody cage may help resist postoperative kyphotic progression, a known failure mechanism in patients treated with SBRT and posterior fixation alone [2, 13]. However, this approach carries important implications for postoperative radiation planning. Titanium pedicle screws at the index vertebral level are known to create dosimetric perturbations, and an anterior titanium cage, given its higher atomic number, may pose additional challenges for SBRT dose planning. Metal artifact reduction protocols and beam arrangements that avoid direct irradiation through titanium implants can mitigate, but not eliminate, these perturbations. Notably, the endoscopic transpedicular approach in this technique allows direct visualization and removal of ventral epidural tumor, including the tumor–cord interface. This direct surgical decompression may reduce reliance on SBRT to sterilize the region immediately adjacent to the spinal cord, potentially mitigating the dosimetric concern of a safety margin

dorsal to the cage. Nonetheless, multidisciplinary discussion with the radiation oncology team regarding implant configuration is strongly recommended when postoperative SBRT is anticipated.

Third, the choice of anterior reconstruction material warrants careful consideration. While polymethylmethacrylate (PMMA) augmentation can provide immediate structural support, it carries risks of cement leakage, thermal neural injury, and venous embolism. An expandable titanium cage, by contrast, can be delivered in a collapsed configuration through the narrow transpedicular corridor and expanded in situ, thereby achieving reliable anterior column support without cement-related risks [14]. With advances in systemic therapies—including targeted agents and immunotherapy—survival in metastatic spine disease is increasingly prolonged, and titanium's osteoconductive properties may offer a theoretically meaningful long-term benefit in patients with extended life expectancy. Nevertheless, osseointegration was not a primary rationale for implant selection in this case, and its clinical relevance in the typical palliative patient with limited survival remains uncertain [15]. Furthermore, the combination of endoscopic visualization and expandable cage technology appears to facilitate this procedure. The cage can be inserted and expanded through the narrow transpedicular corridor, allowing anterior column support through a limited posterior working channel. Notably, the preservation of the posterior ligamentous complex combined with anterior column reconstruction may theoretically satisfy the biomechanical requirements for a shorter instrumentation construct than employed here, potentially further reducing surgical morbidity; this possibility warrants prospective biomechanical and clinical investigation.

The concept of transpedicular intrabody reconstruction has recently been validated for severe vertebral collapse in metastatic spinal tumors and Kümmell's disease using minimally invasive tubular systems [6, 7]. In the present case, we applied this concept using an entirely endoscopic transpedicular technique. This case suggests that endoscopic spine surgery may have reconstructive applications in selected patients with metastatic disease, beyond its more established role in decompression. Our experience suggests that UBE may offer general minimally invasive advantages, including enhanced visualization and limited soft-tissue disruption, in achieving decompression and anterior support through a posterior-only approach, although these potential benefits were not specifically assessed in this case.

Potential concerns include tumor cell dissemination through irrigation fluid and the limited working space of the endoscopic corridor. However, there is currently no evidence that endoscopic spine surgery increases local recurrence risk compared with conventional minimally invasive techniques [8].

This report has several limitations. First, it describes a single case, which limits generalizability and does not allow comparison with open, microscopic, or tubular minimally invasive approaches. Second, follow-up was short, so long-term construct durability, cage subsidence, local tumor control, and the need for revision surgery could not be assessed. Third, perioperative variables such as operative time, blood loss, transfusion requirement, length of stay, and complications were not systematically analyzed. Fourth, the oncologic implications of this strategy, including local tumor control and its role in multimodal treatment, cannot be determined from a single case. Despite these limitations, this case suggests that UBE-

assisted transpedicular intrabody cage augmentation can be performed as a posterior-only technique allowing ventral decompression and anterior column support in a selected patient with metastatic burst fracture.

Conclusion

This report describes the technical feasibility of UBE-assisted transpedicular partial corpectomy with expandable cage augmentation for a metastatic pathologic burst fracture. In this patient, the technique allowed posterior-only ventral decompression and anterior column support while preserving the posterior ligamentous structures. However, broader applicability, safety, and long-term durability remain to be established in larger series with longer follow-up.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

This case report was approved by the Institutional Review Board of our institution (IRB No. 2026AN0132) and was conducted in accordance with the Declaration of Helsinki. Written informed consent for publication was obtained from the patient.

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Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Author Contribution

Donghyun Kim and Subum Lee wrote the main manuscript text. Junseok W. Hur and Younggyu Oh prepared the figures. Sungjae An contributed to data collection and manuscript revision. All authors reviewed the manuscript.

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Figures

Figure 1

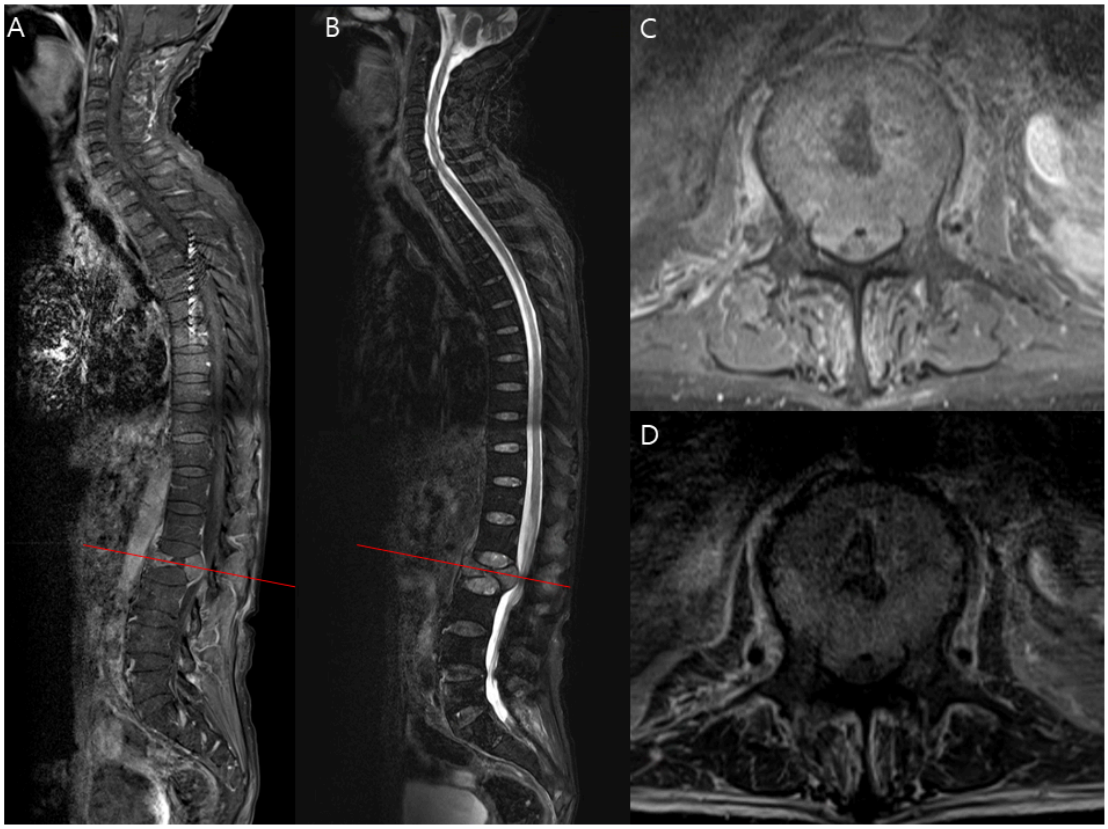


Figure 1

Preoperative magnetic resonance imaging.

(A) Sagittal contrast-enhanced T1-weighted, (B) sagittal T2-weighted, (C) axial contrast-enhanced T1-weighted, and (D) axial T2-weighted images. Red lines indicate the corresponding levels. A solitary metastatic lesion with a pathologic burst fracture is seen at L2, causing severe compression of the thecal sac and both lateral recesses. Cerebrospinal fluid signal is obliterated on T2-weighted images.

Figure 2

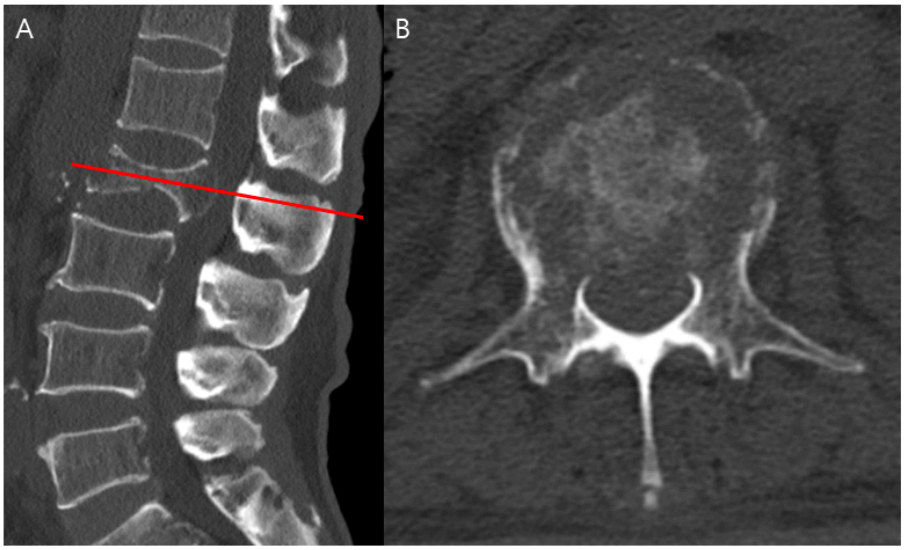


Figure 2

Preoperative computed tomography.

(A) Sagittal and (B) axial images. Red lines indicate the corresponding levels. An osteolytic pathologic burst fracture is present at L2, involving both the vertebral body and pedicle.

Figure 3

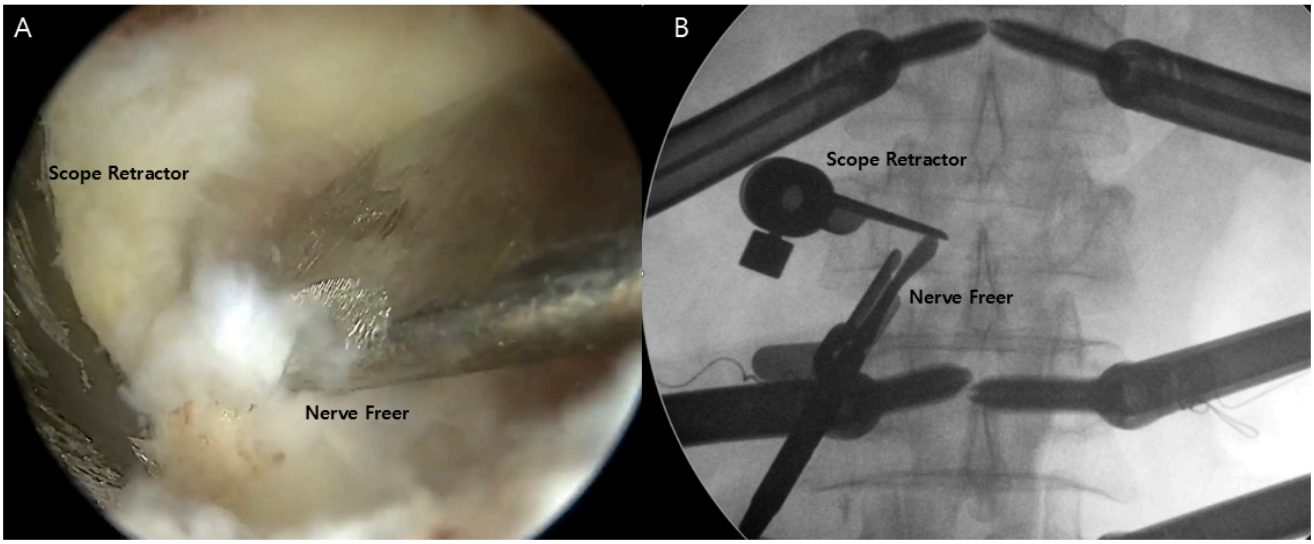


Figure 3

Intraoperative images of the initial docking point.

(A) Endoscopic view of the initial docking point. After initial cortical bone drilling just medial to the left L2 pedicle using a biportal endoscopic approach, a nerve freer was placed at the drilled site. (B) Fluoroscopic view confirming the scope retractor and nerve freer positioned medial to the left L2 pedicle.

Figure 4

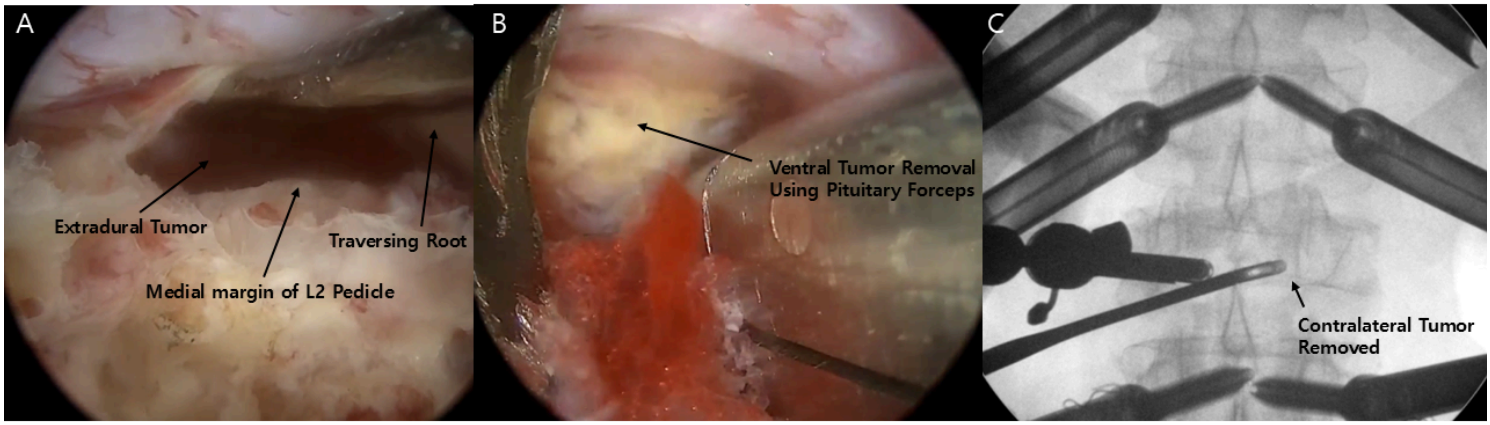


Figure 4

Endoscopic decompression and tumor removal.
(A) Endoscopic view after pediclectomy, showing ventral access to the thecal sac with gentle elevation using a nerve freer. (B) Tumor removal with pituitary forceps. (C) Fluoroscopic view demonstrating removal of the contralateral ventral tumor through a left-sided approach.

Figure 5

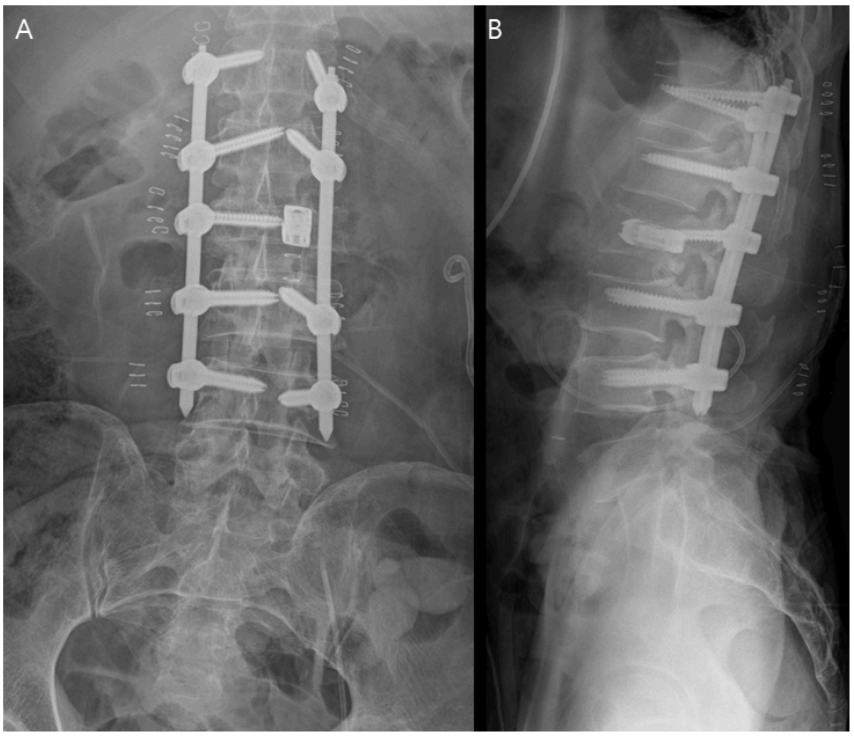


Figure 5

Postoperative radiographs.
(A) Anteroposterior and (B) lateral views showing L2 intrabody cage augmentation for anterior column support.