eXtreme Lateral Interbody Fusion (XLIF®)

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XLIF® Corpectomy

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Thoracolumbar corpectomies have traditionally been performed via an open anterior approach. This open procedure allows resectioning of the anterior, load-bearing column to treat tumors,[1] vertebral burst fractures,[2-6] or vertebral osteomyelitis[7] and can be readily paired with anterolateral or posterior fixation.[8-12] The benefits of this procedure include a large, anterior working space, a relatively low learning curve (standard techniques for corpectomy), and relative ease of handling intraoperative complications. The surgical disadvantages to this procedure, however, include a large wound field (Fig. 21-1), which results in an increased infection rate; an increased recovery time; and an increased likelihood for intraoperative complications. In addition, working anterior to posterior increases the potential for spinal cord injuries by the posterior migration of retropulsed fragments.[10,13] These

FIG. 21-1 This patient shows a thoracotomy incision.

artifacts of open techniques result in high complication rates—namely, intercostal neuralgia and postthoracotomy pain[14-17]—and the use of dual-lumen intubation for ipsilateral lung deflation requires the placement of a chest tube postoperatively and greatly increases the risk for atelectasis and pneumonia. The open approach requires an approach surgeon whose scheduling conflicts can delay immediate decompression for patients with traumatic injuries, which may increase the likelihood for permanent disability.[18-20]

The use of endoscopic (thoracoscopic and laparoscopic) techniques for anterior thoracolumbar reconstruction began in the second half of the 1990s,[17,21-28] and has not been widely adopted because of the extended surgical times, steep learning curves, expensive equipment, and a relative inability to control intraoperative complications.[16,29-31] Recently, mini-open techniques have been introduced to control these intraoperative issues without the postoperative complications common to the historical wide-open procedures.[8,9,11,12,32]

This chapter introduces a novel technique for thoracolumbar corpectomies using extreme lateral interbody fusion (XLIF; NuVasive®, Inc., San Diego, CA), which has many advantages, including a direct, mini-open corridor to the pathology, decreased tissue disruption, a decreased infection rate (because of the small wound field), decreased operative time, decreased postoperative pain, and decreased recovery time. In addition, XLIF provides an increased ability to manage intraoperative complications compared with endoscopic techniques, allows the surgeon to use familiar general surgical techniques similar to open procedures (moderated learning curves), and gives the surgeon the opportunity for immediate decompression (because an approach surgeon is not needed). As a result, there is a decrease in the overall cost and resources used.

Clinical Experience

Between February 2007 and February 2008, 19 patients underwent corpectomies via an XLIF approach by three neurosurgeons in one private neurosurgical practice in Las Vegas, Nevada (Box 21-1). Four patients underwent posterior transpedicular fixation from one level above to one level below the corpectomized level. The remaining 15 patients received lateral plating without posterior fixation.

BOX 21-1 Treatment Demographics

Sex	Levels
Male: 9	T8: 3
Female: 10	T9: 2
	T10: 2
Pathology	T12: 3
Trauma: 7	L1: 4
Compression fracture: degenerative scoliosis: 3	L2: 3
Tumor: 6	L3: 1
Infection: 3	L4: 1

Mean age: 44.7 years. Age range: 18 to 72 years.

Surgical Technique

In our clinic, we have found the XLIF approach for corpectomies to be safe and reproducible from T8 to L4. Thoracic corpectomies are approached by following the access techniques described for thoracic XLIF disc procedures, but require rib resectioning for retractor access. Lumbar corpectomies use the approach techniques of lumbar XLIF but are generally more difficult because of the thick psoas muscle in this area. Corpectomies in and around the thoracolumbar junction require navigational considerations around the diaphragm. All operations have been performed by a single neurosurgeon without an approach surgeon. For thoracic levels, normal single-lumen ventilation is used, and patients are placed in the lateral decubitus position. All patients are administered preoperative antibiotic agents and steroids. Intraoperative localization is accomplished using direct visualization with biplanar fluoroscopy—the treatment levels are identified and the vertebral bodies are marked (Fig. 21-2, *A* and *B*).

An oblique incision approximately 4 cm long is made 90 degrees directly lateral to the anterior axis of the vertebral column. Variable lengths of rib are resected to allow the MaXcess® III Retractor System (NuVasive, Inc.) to be inserted and expanded (Fig. 21-2, *C* and *D*). Using normal ventilation, the lung is deflected using the MaXcess Dilators, which are incrementally increased in diameter until the Retractor is inserted (Fig. 21-2, *E* through *G*). For lumbar levels, motor evoked potentials are monitored using the NeuroVision® monitoring system (NuVasive, Inc.).

Dilators are used to identify and localize nervous tissue disruption. The locations are confirmed with fluoroscopy, and the Retractor is carefully inserted, bordering the lung (Fig. 21-2, *H* through *J*). The fourth Blade was added to the MaXcess Retractor to define the working space for vertebral body removal. Working from the patient's posterior aspect, the three standard Blades of the Retractor outline the anterior border of the thecal sac and the superior/inferior aspects of the adjacent discs (see Fig. 21-2, *H* through *J*). As seen in Fig. 21-2 *K*, the incision required for the XLIF procedure is minimal.

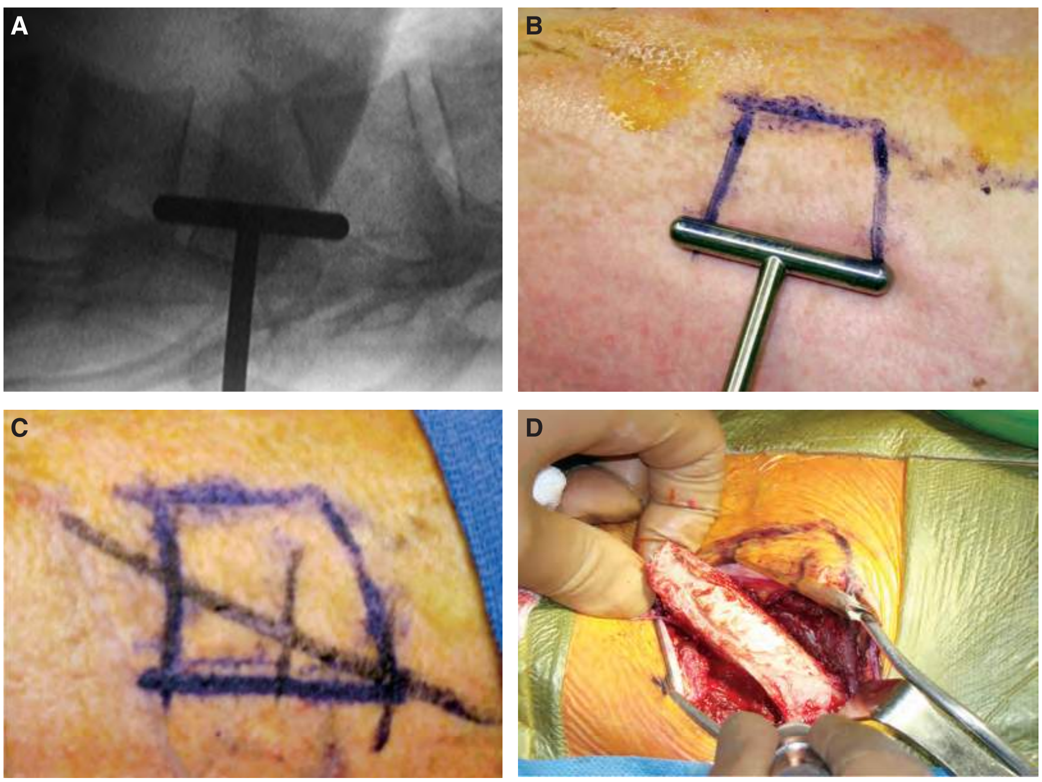

FIG. 21-2 **A,** Localization for a traumatic L1 burst fracture is seen on the lateral intraoperative fluoroscopic view. **B,** The location of the vertebral body is mapped on the skin for corpectomy. **C,** A rib and vertebra are mapped on the skin preoperatively. **D,** A portion of a rib is resected for greater access.

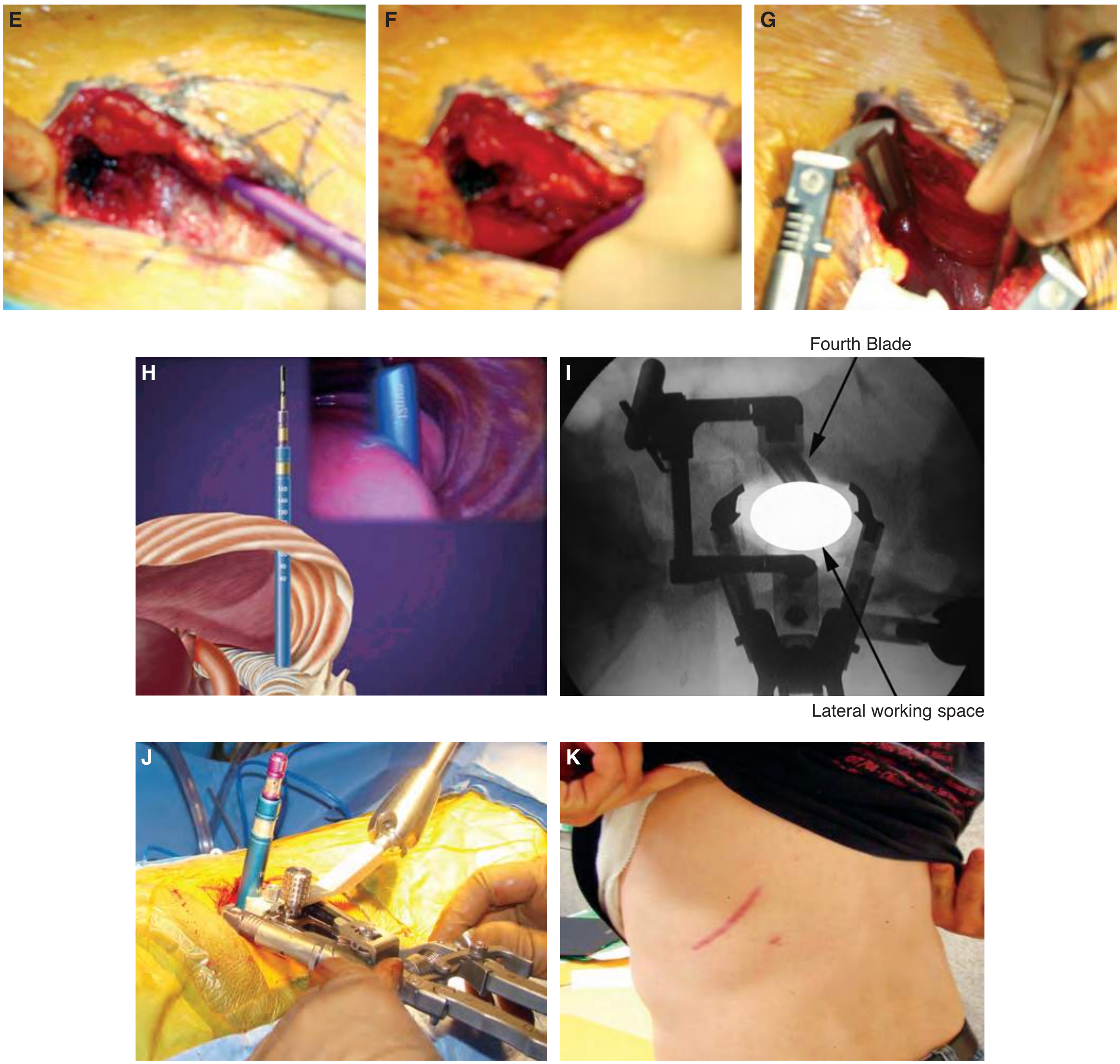

FIG. 21-2, cont'd **E-G,** The progression of the thoracic approach is shown, including the placement of a sequential Dilator and subsequent Retractor advancement and expansion. **H** and **I,** The MaXcess Dilators and Retractor (with the fourth Blade attached) are placed in the thorax. In **J,** the lateral working space is defined by the borders of the Retractor Blades, with the border of the thecal sac on the posterior aspect. **K,** The incision for XLIF is minimal.

After achieving sufficient exposure, the standard technique for corpectomy is used, beginning with the vertebral body and adjacent disc removal. The anterior segment is removed, and the corpectomized segments replaced with corpectomy cages (Fig. 21-3, *A* through *F*). In four of the 19 patients treated in this manner at our institution, posterior transpedicular fixation and scaffolding were used to increase structural salience. In the remaining 15 patients, lateral plating was used for anterior column stabilization.

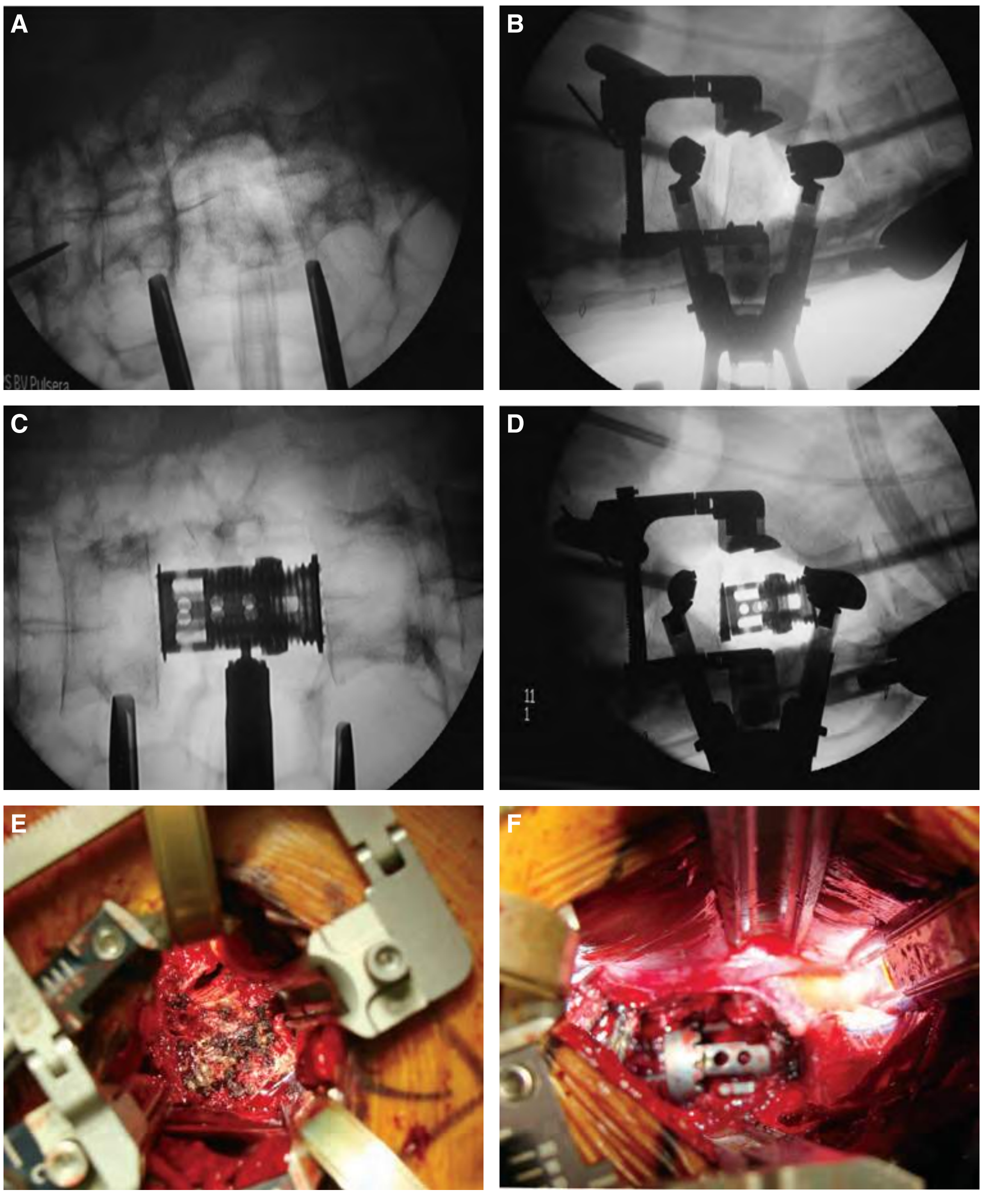

FIG. 21-3 **A-F,** These progressive intraoperative images show vertebral body targeting and cage placement using the MaXcess Retractor with the fourth Blade attached.

BOX 21-2 Intraoperative Series Statistics (19 Patients)

Operating Room Time

Mean: 136 minutes

Range: 35 to 394 minutes

Estimated Blood Loss

Median: 220 milliters

Range: 50 to 2200 milliters

Clinical Results

As of this writing, 12-month follow-up is available for only two patients. No serious intraoperative or postoperative complications have been reported, and no revisions have been performed. Box 21-2 lists operating room times and estimated blood loss (EBL) as obtained via retrospective chart review. The largest volume of EBL was the result of severe trauma rather than surgical manipulation. Because the majority of the patients in the study were admitted to the emergency room for acute trauma, pain surveys were not obtained before surgery for 10 of the 19 patients. The following three case studies are from this series.

Case Examples

CASE ONE

An 18-year-old woman was involved in a 90 mph motor vehicle accident that caused her vehicle to roll over. She presented to the emergency room with complete motor paraplegia caused by an L1 burst fracture (Fig. 21-4, *A* through *C*). The neurosurgeon on call was available, but no approach surgeon could arrive until the following morning. The surgery began approximately 45 minutes after the patient arrived at the emergency room. The patient underwent a complete L1 corpectomy via an XLIF approach, facilitated by the MaXcess Retractor with the fourth Blade attached (Fig. 21-4, *D* through *F*).

Partial corpectomies were performed at T12 and L2, and the L1 space was fitted with an expandable titanium cage. Because of the extreme nature of the fracture, bilateral transpedicular screws were used at T12 and L2 (Fig. 21-4, *G* and *H*). The operating room time was 158 minutes and the EBL was 220 ml. The patient was discharged (ambulatory) 5 days postoperatively.

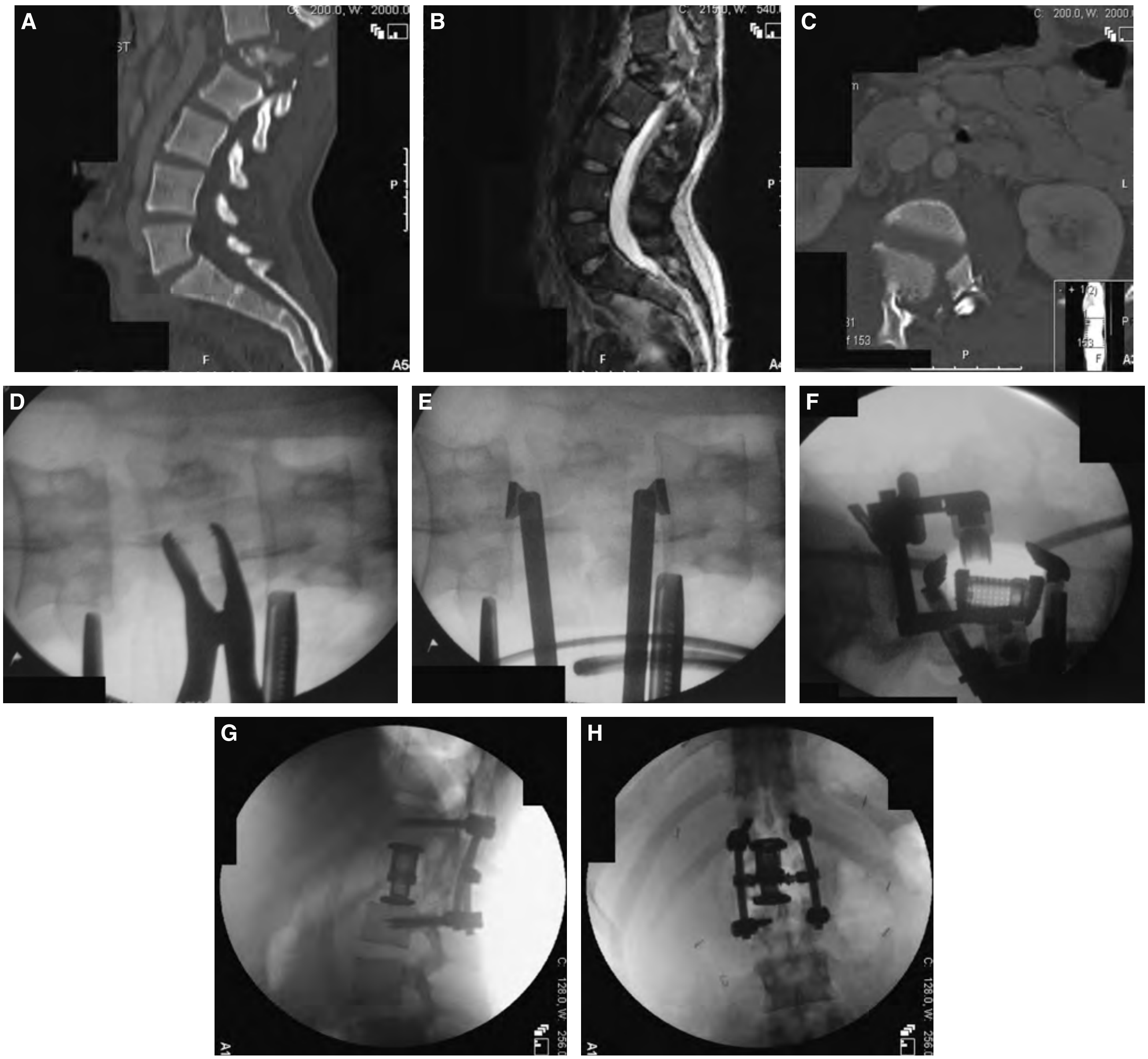

FIG. 21-4 **A-C,** This 18-year-old woman was in a motor vehicle accident. Preoperative computed tomography (CT) and magnetic resonance imaging (MRI) showed an L1 burst fracture. **D-H.** These intraoperative fluoroscopic images show the lateral corpectomy procedure and final construct.

CASE TWO

A 75-year-old woman presented with a 20-year history of increasingly severe intractable back pain and bilateral leg symptoms. She was not able to ambulate independently and received minimal relief from recumbency. Conservative treatment, including physical therapy and injections, was unsuccessful. She had obtained two previous surgical consultations—one surgeon suggested immediate surgical intervention, and the second deemed the case too severe to operate. She had surgery on her lower back in 1989 and a 20-year history of smoking. The physical examination revealed an obvious scoliotic deformity; a patchy, diminished sensation in a stocking distribution in her lower extremities; and a Lasègue maneuver bilaterally, with flexion and extension limited to approximately 25% of normal. MRI and CT scans revealed a compression fracture with cord compression at L1 and a retropulsed fragment in the T12-L1 and L1-2 region. She also had a scoliotic deformity at L3-4 and L4-5 with a Knudson phenomenon. The surgical strategy was to perform an L1 corpectomy via an XLIF approach and fusion using an expandable cage and lateral plating. Because this addressed only the burst fracture and not the scoliotic deformity, minimally invasive L3-5 interbody fusion using the XLIF procedure was also planned. The patient underwent complete discectomies at L3-4 and L4-5 with an XLIF approach. A poly-ether-ether-ketone (PEEK) implant (CoRoent® XL, NuVasive, Inc.) with bone from a local source and bone morphogenic protein (BMP) was placed, with lateral Plates (XLP™, NuVasive, Inc.) at L3-4 and L4-5. Through a separate fascial incision, a complete corpectomy was performed at L1, with complete discectomies at L1-2 and L2-3. An expandable cage was implanted at L1 with bone from a local source, BMP, and rib for structural purposes, and anterolateral plating was placed from T12 through L2 (Fig. 21-5, *A* through *G*). Table 21-1 shows the time and EBL for each procedure. The patient was discharged 4 days postoperatively, ambulating with assistance.

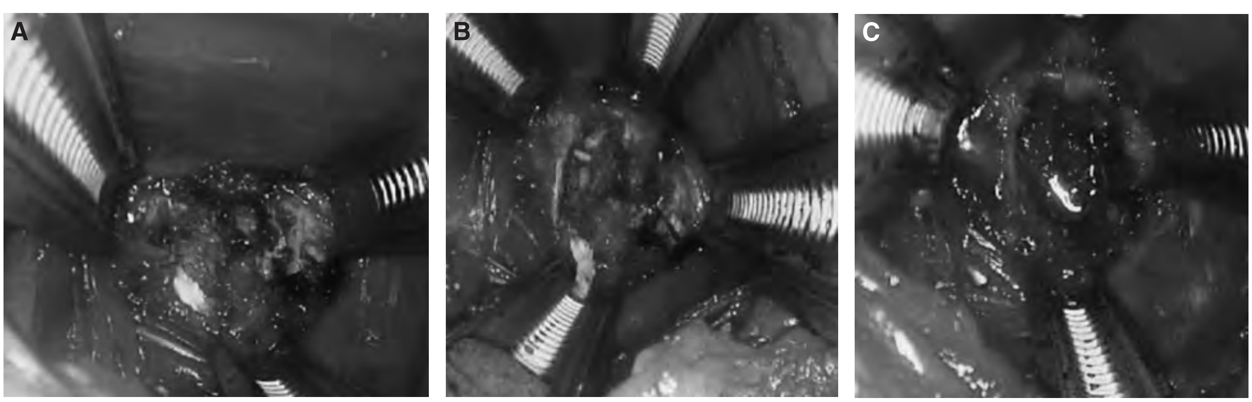

FIG. 21-5 This 75-year-old woman had a 20-year history of increasingly severe back pain and bilateral leg symptoms. A lateral corpectomy was performed to treat an L1 burst fracture with retropulsed fragments, in addition to an L3-5 XLIF for correction of scoliosis. **A,** L1 was exposed. **B** and **C,** The vertebral body was extravasated.

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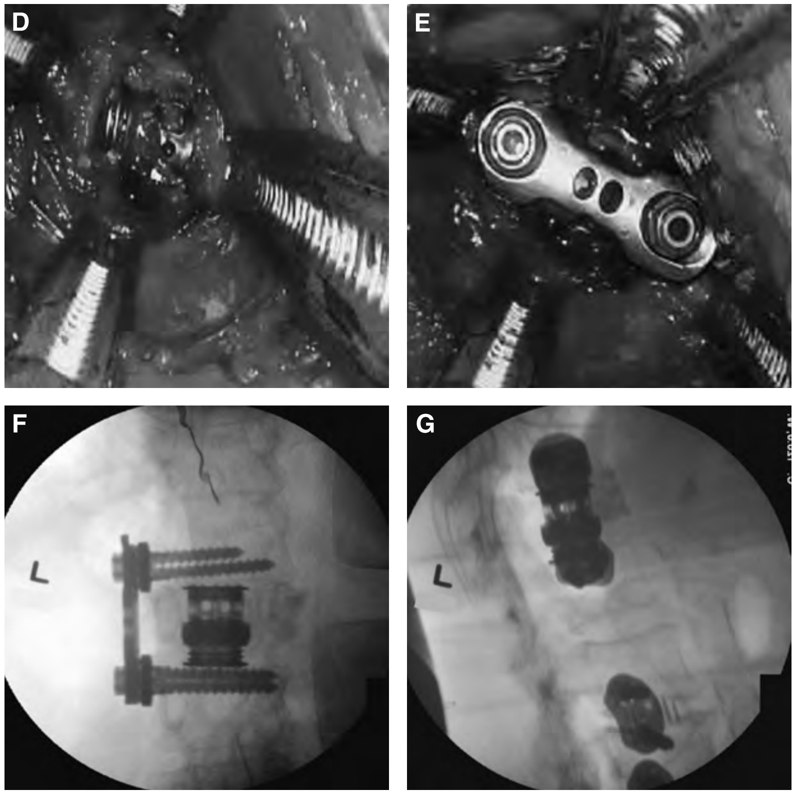

FIG. 21-5, cont'd **D,** An expandable cage was placed. **E,** The lateral Plate is placed. **F** and **G,** Anteroposterior and lateral fluoroscopic images of the final constructs were obtained.

TABLE 21-1 Results for L1 Corpectomy Through an XLIF Approach With L3-5 XLIF to Correct Scoliotic Deformity

Level	Procedure	Time (minutes)	Estimated Blood Loss (ml)
L1	Corpectomy	55	150
L3-4	XLIF	10	10
	XLP	10	5
L4-5	XLIF	10	15
	XLP	10	5
TOTAL		95	185

XLIF, extreme lateral interbody fusion; *XLP*, lateral Plate.

CASE THREE

A 30-year-old woman presented with a 4-week history of paraparesis. She was unable to stand or walk independently. She had urinary incontinence 2 days before admission. Imaging revealed a very large intradural tumor that was confirmed by pathology to be a neurofibroma described as an intradural, extramedullary spinal cord tumor at T9-10 with severe cord compression and injury (Fig. 21-6, *A* and *B*). The surgical plan was to perform a complete corpectomy at T9 with a partial corpectomy at T10 via a transthoracic XLIF approach, with rib harvesting through a separate fascial incision. Discectomies were to be completed at T8-9 and T9-10, with intradural exploration for complete excision of meningioma. A lumbar drain was inserted before surgery for cerebrospinal fluid (CSF) drainage. Interbody fusion was carried out using an expandable titanium cage with anterolateral plating (Fig. 21-6, *C* through *J*). The surgery was performed without complications, and a separate chest tube was placed postoperatively. The operating room time was 156 minutes and the EBL was 220 ml. The chest tube and lumbar drain were removed 12 hours and 48 hours after surgery, respectively. The patient was discharged, ambulatory, 72 hours postoperatively. At the 6-month follow-up, she is fully functional and asymptomatic. She does have headaches; these are probably spinal headaches caused by CSF leakage.

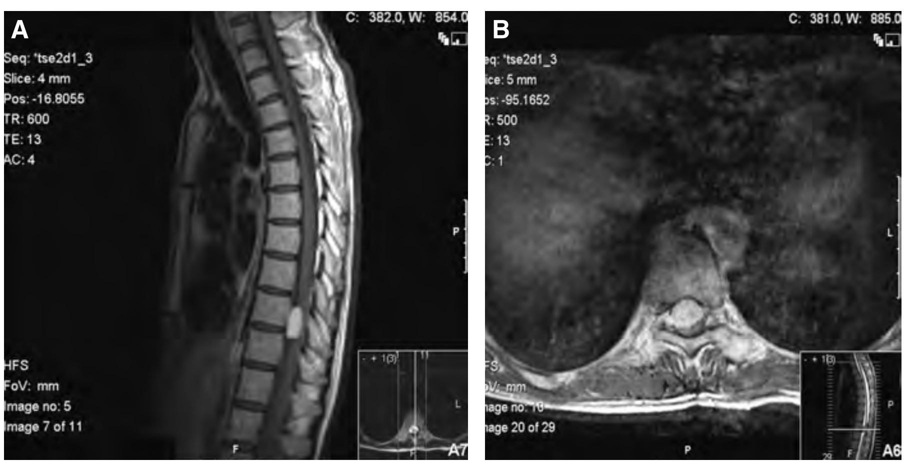

FIG. 21-6 This 30-year-old woman had a 4-week history of paraparesis and was unable to stand or walk independently. **A** and **B,** Preoperative MRIs showed a very large intradural, extramedullary spinal cord tumor at T9-10, with severe cord compression and injury. *Continued*

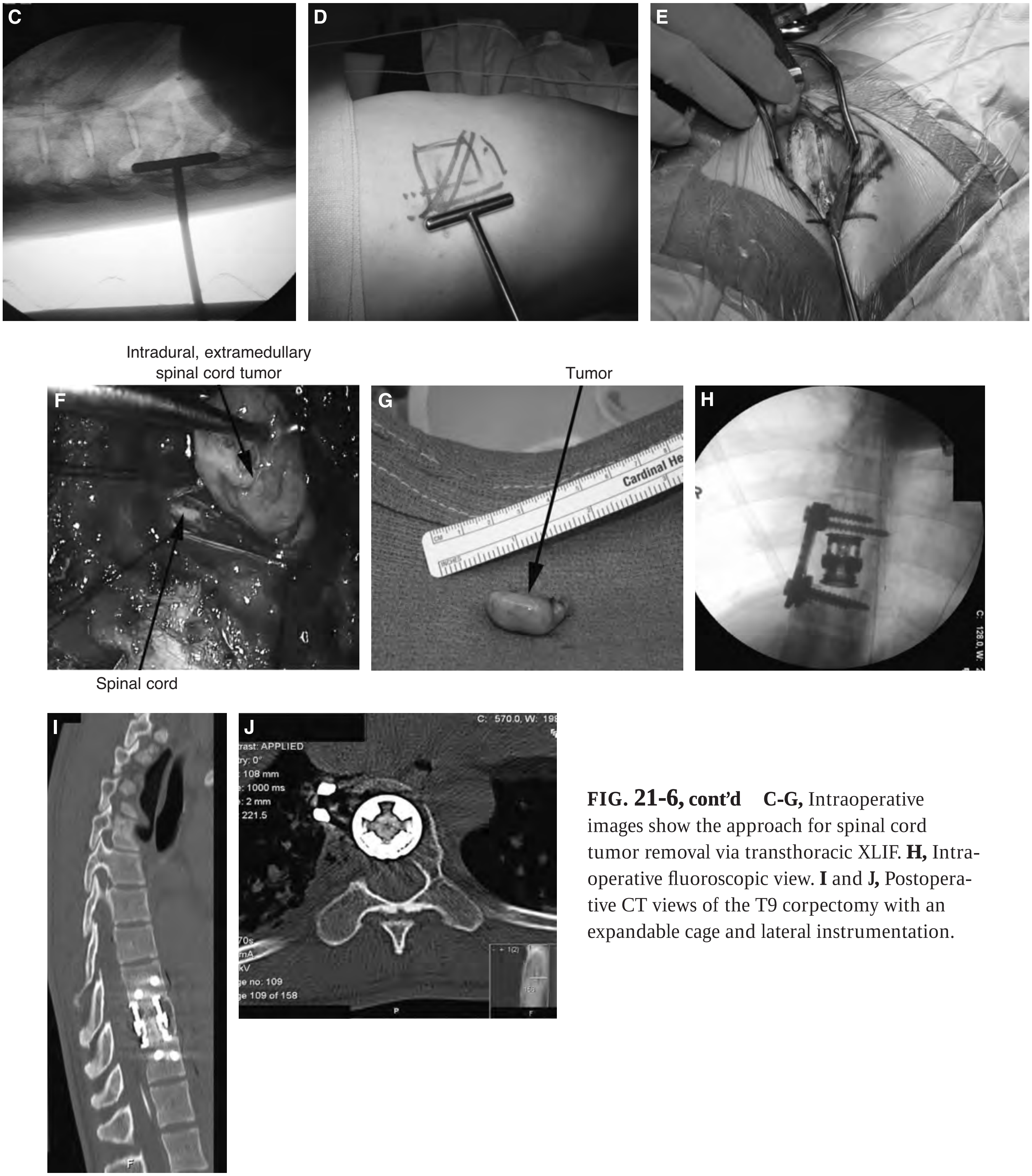

FIG. 21-6, cont'd **C-G,** Intraoperative images show the approach for spinal cord tumor removal via transthoracic XLIF. **H,** Intraoperative fluoroscopic view. **I** and **J,** Postoperative CT views of the T9 corpectomy with an expandable cage and lateral instrumentation.

Complications and Benefits of the XLIF Approach

Major concerns when performing thoracolumbar corpectomies to treat patients with traumatic injuries are immediate decompression,[18-20] the manipulation of retropulsed fragments, and the stabilization of the anterior load-bearing column.[8,9,11,12,32] The XLIF approach for corpectomy does not require an approach surgeon, which is important because most extreme trauma cases require urgent intervention.

In an anterior approach, retropulsed fragments have a high risk of posterior migration during extravasation of the vertebral body. Using an XLIF approach and working within the borders of the retractor system allows a clean, 90-degree environment that borders the adjacent vertebral segments and the thecal sac posteriorly. This arrangement decreases the likelihood of posterior fragment migration. In our series, no spinal cord damage resulted from migrating retropulsed fragments. In addition, localizing the retractor allows anatomic definition in cases that lack regular anatomic landmarks because of injury.

Finally, our series shows that the working space created using a true lateral, mini-open approach is sufficient to safely and reproducibly perform corpectomies. Although no intraoperative complications occurred in our series, we believe that they would be easily contained because of the robust exposure at the site, regardless of the relatively small incision.

Conclusion

The results of our series of 19 patients who underwent lateral thoracolumbar corpectomies suggest that these procedures can be performed safely and reproducibly without an access surgeon. The mini-open approach causes less soft tissue disruption and provides a direct corridor to the pathology. The MaXcess Retractor system, with the fourth Blade attached, allows the anatomy to be localized and defined and protects the spinal cord from retropulsed fragments. Most importantly, this approach does not have the steep learning curve associated with endoscopic techniques. This system involves the same general principles and procedures as corpectomy via an open approach, but with fewer operative morbidities.

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