Lumbar Extracavitary Corpectomy With a Single Stage Circumferential Arthrodesis: Surgical Technique and Clinical Series

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Abstract

Circumferential arthrodesis and reconstruction is necessary after a lumbar corpectomy in the setting of malignancy and infection. The advent of expandable cage technology now allows for safe anterior column reconstruction via a posterior approach with no transection and minimal retraction of the lumbar spinal nerve roots.

Fifteen patients underwent a single-stage, circumferential corpectomy and anterior spinal reconstruction with an expandable cage via a midline, posterior, lateral lumbar extracavitary approach. Posterior segmental pedicle screw fixation and iliac crest bone graft was used in all cases.

Fifteen lumbar extracavitary corpectomy nerve root-sparing procedures have been performed to date, with at least 1-year follow-up (12 tumors/3 infections). No patient suffered any neurological complications. One patient suffered from a postoperative myocardial infarction 10 days after the procedure. Two patients had medical complications that were treated without sequelae.

We present a technical description and case series of patients undergoing a single-stage, circumferential corpectomy and anterior spinal reconstruction with an expandable cage via a midline, posterior, lateral lumbar extracavitary approach with at least 1-year follow-up. The technique is safe, technically feasible, and obviates an anterior approach in this oftentimes critically ill patient population.

Infections and metastatic disease of the lumbar spine are common clinical entities that often necessitate a complex spinal decompression and reconstruction.[1-3] Traditionally, these pathological conditions have been treated by a staged anterior and posterior decompression and fusion.[4-6] While an anterior approach provides excellent visualization of the vertebral body and pathological condition, this visualization may result in iatrogenic morbidity to an oftentimes critically ill patient.[7] Posterolateral approaches allow for excellent ventral decompression with safe visualization of the neural elements.[2,6,8,9] The lateral extracavitary approach was first popularized by Larson and colleagues[10] in 1976. The unique anatomy of the lumbar spine and the inability to perform the spinal reconstruction around the lumbar nerve roots has limited its widespread acceptance. Other criticisms of the lateral extracavitary technique have been its association with increased blood loss and poor visualization across the midline.[5,11-13] The extent of visualization is debatable, and in most cases, a unilateral approach may be performed safely to the contralateral pedicle. A bilateral approach is appropriate in situations of primary malignancy or solitary metastatic disease where an en bloc spondylectomy is advisable.

With the advent of expandable metallic cages, an all-posterior spinal reconstruction can be accomplished without sacrificing the lumbar spinal nerve roots. Recently, Hunt and colleagues[11] described the use of an expandable cage in a single patient. The following manuscript presents a clinical series of 15 patients treated for lumbar osteomyelitis and metastatic spinal disease via a single-stage, circumferential corpectomy and anterior spinal reconstruction with an expandable cage via a midline, posterior, lateral lumbar extracavitary approach with at least 1-year follow-up.

Materials & Methods

Between September 2005 and August 2006, 15 patients underwent a single-stage, circumferential corpectomy and anterior spinal reconstruction with an expandable cage via a midline, posterior, lateral lumbar extracavitary approach. Posterior segmental pedicle screw fixation and iliac crest bone graft was used in all cases (Table). Indications for surgical intervention included 12 tumors with vertebral body collapse and retropulsion of bone fragments into the spinal canal, and 3 patients with progressive spinal infections and resultant spinal deformity despite appropriate antibiotic therapy.

Operative Technique

The patient was placed on a Jackson radiolucent spine frame (Mizuho OS, Union City, California) that allows for log-rolling in the standard prone position. This table

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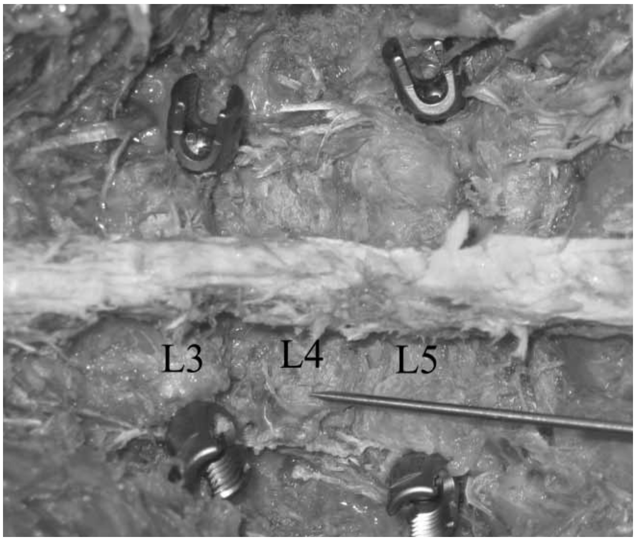

Figure 1. Transpedicular screws are placed bilaterally into L3 and L5. The left L3-4 facet capsule is identified representing the L4 pedicle entrance.

Figure 2. A wide L3-4 laminectomy and complete facetectomy of L3-4 on the left is completed. This allows for the skeletonization of the left L4 pedicle which is identified with the letter *P*. A white asterisk (*) denotes the L3 and L4 exiting nerve root. A cobb elevator is seen on the lateral edge of the vertebral body. Note that the left L4 transverse process has been resected.

allows for both tilting and simultaneous use of an image amplifier. A standard midline posterior subperiosteal dissection is carried out above and below the injured vertebral body. Transpedicular screws are placed bilaterally above and below the involved vertebra (Figure 1). The number of levels to be instrumented is variable, depending on the bone quality, severity of deformity, and pathology to be addressed. We typically advocate 2 levels of fixation above and below the level of pathology. A rod is placed unilaterally (ie, contralateral to the side of the pediculectomy/corpectomy) and gentle distraction is applied across the segments to be addressed to stabilize these segments during the decompression.

The corpectomy is initiated by skeletonizing the corresponding pedicle. Laminectomies and completed facetectomies are performed at the level of the pathology as well as above and below the involved vertebrae (Figure 2). This step is essential to maximize the cephalad-caudad working space between the nerve roots, which becomes critical during the expandable cage placement. At this point, the transverse process of the affected vertebra is resected using a kerrison rongeur, exposing the lateral edge of the vertebral body. Subperiosteal dissection is performed with a cobb and packing sponge around the vertebral body. Subperiosteal dissection is much more technically challenging in situations of infections where tissue planes becomes adherent. We advise a slow dissection ensuring a subperiosteal exposure limiting the blood loss and potential for inadvertent vascular injury in the anterior abdominal cavity.

A high-speed burr is then used to remove the lateral pedicle and vertebral body wall. The medial edge of the pedicle is left intact to protect the exiting nerve root. With the dorsal cortex of the vertebral body and the

Table. Patient Demographic, Disease and Surgical Information

Case Number	Age/Sex	Pathology (Level)	Surgical Levels	Estimated Blood Loss (mL)	Preoperative Neurological Status (Frankel)	Postoperative Neurological Status (Frankel)	Follow-up (Months)
1	78/m	Metastatic Prostate CA (L4)	L2-S1	3200	Incomplete C	Incomplete C	13
2	45/f	Recurrent Giant Cell (L2)	T12-L4	800	Incomplete D	Intact E	23
3	58/f	Metastatic Endometrial CA (L5)	L3-Pelvis	2600	Incomplete C	Incomplete C	19
4	62/m	Metastatic Prostate CA (L1)	T11-L3	1800	Incomplete D	Incomplete D	19
5	68/f	Metastatic Breast CA (L3)	L1-L5	1800	Intact E	Intact E	24
6	57/f	Metastatic Breast CA (L4)	L2-S1	2100	Incomplete D	Incomplete D	18
7	64/m	Osteomyelitis/Discitis (L1/2)	T11-L4	2500	Intact E	Intact E	22
8	46/m	Telengiectatic Osteosarcoma (L1)	T11-L3	1400	Intact E	Intact E	14
9	44/m	Lymphoma (L5)	L3-S1	1300	Incomplete D	Intact E	13
10	44/f	Osteomyelitis/Discitis (L3/4)	L1-S1	3800	Intact E	Intact E	26
11	73/m	Metastatic Prostate CA (L2)	T12-L4	2400	Incomplete C	Incomplete C	22
12	68/f	Metastatic Breast CA (L4)	L2-S1	2700	Incomplete D	Intact E	14
13	65/m	Metastatic Prostate CA (L3)	L1-L5	3100	Incomplete D	Incomplete D	17
14	69/f	Metastatic Breast CA (L4)	L2-S1	3400	Intact E	Intact E	18
15	71/f	Osteomyelitis/Discitis (L2-3)	T12-L5	3700	Intact E	Intact E	21

Figure 3. The L4 vertebral body has been resected and the defect is represented by the large black arrow. The asterisk (*) denotes the L3 nerve root and the plus sign (+) denotes the L4 nerve root.

Figure 4. An expandable interbody cage is placed parallel to the exiting L3 and L4 nerve roots as marked by the 2 k-wires. Note that the cage is perpendicular to the dural sac while it is advanced into corpectomy defect.

medial wall of the pedicle intact, the surgeon can safely work as the neural elements are protected. A combination of ring curettes is used to perform the discectomy above and below the involved vertebrae. Discectomies are done prior to lateral body wall resection in situations of a primary malignancy or solitary boney metastasis to ensure no local contamination. In the majority of situations, this is usually not necessary. Once the discectomies are completed, the vertebral body is hollowed using the high speed burr and curved curettes. Log-rolling the table away from the surgeon allows for visualization across the midline to the contralateral vertebral body wall. Once the vertebral body has been

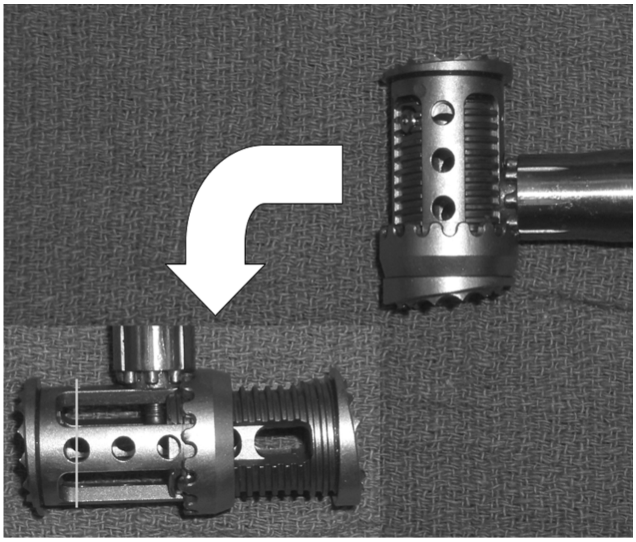

Figure 5. The cage is then rotated 90° within the corpectomy site and expanded as demonstrated by the photograph.

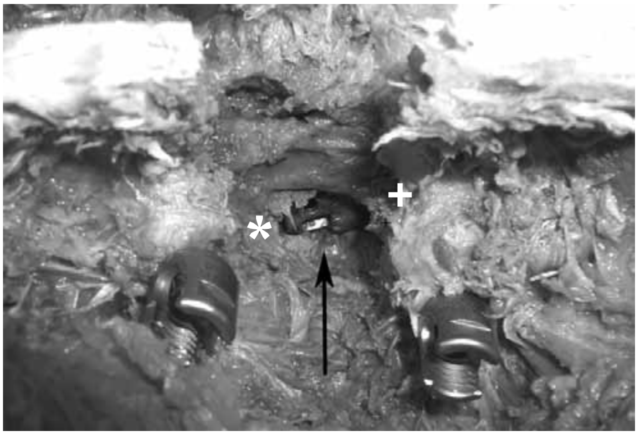

Figure 6. The cage is then fully engaged within the corpectomy site with minimal retraction of the exiting nerve roots (* L3 nerve root, + L4 nerve root).

created into an egg-shell, the end plates and dorsal cortex are depressed into the defect. We have found that preserving the dorsal cortex minimizes epidural bleeding into the operative site (Figure 3). At this point, if the contralateral vertebral wall needs to be resected, then facetectomies can be performed on the opposite side. In most situations, this is unnecessary and the bone preserved serves as an enlarged posterolateral fusion bed.

The most challenging part of the procedure occurs with the expandable cage placement. The cage is initially placed parallel to the nerve root on the cephalad side of the affected level (ie, at the level of the pediculectomy). The nerve root is gently retracted caudally as the cage is passed into the corpectomy site (Figure 4). Once inside the prior vertebral body, the cage is rotated 90º until it is perpendicular to the adjacent vertebral endplates (Figure 5). Prior to placement, the cage is filled with iliac crest bone graft in a tightly packed manner to ensure a solid column of bone. Distraction is then

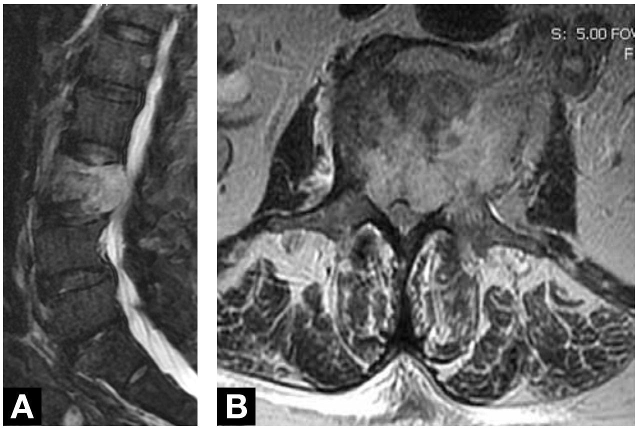

Figure 7. (A) Preoperative Sagittal STIR MRI Lumbar Spine of a 68-year-old female with metastatic breast CA. Patient was noted to have complete destruction of the L3 vertebral body with significant collapse. (B) Preoperative axial images at the L3 level reveal significant soft-tissue compromise of the epidural space. The patient was unable to ambulate secondary to pain.

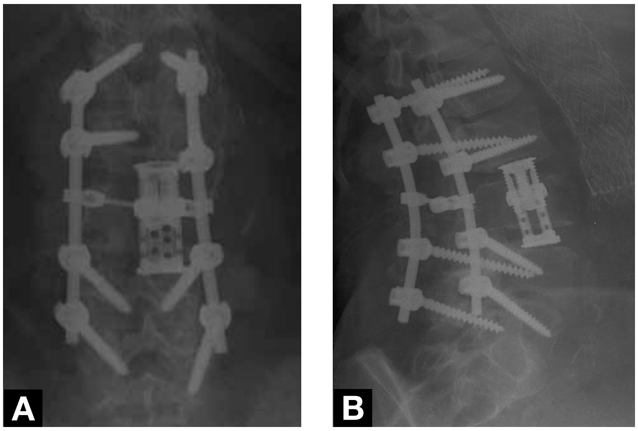

Figure 8. AP (A) and lateral (B) lumbar spine radiographs (2 year follow-up) reveal an extracavitary corpectomy at L3 with an expandable cage placement in the 68-year-old female with metastatic breast CA. The posterior spinal fusion was extended from L1-5. The patient was neurologically intact postoperatively and has had resolution of her symptoms with no recurrence at her most recent 2-year follow-up.

performed under direct fluoroscopy so as to engage the cage against the vertebral endplates in the appropriate position (Figure 6).

Additional bone graft is then packed around the anterior and lateral portions of the cage. The second rod is then placed and the set screws on the initial rod are loosened. Compression is applied bilaterally across the affected segments. All of the set screws are given a final tightening and a cross-link is applied. Radiographs are obtained to confirm adequate placement of the bone graft and instrumentation (Figures 7, 8). Finally, a posterolateral arthrodesis is performed on the contralateral side where the facets have been preserved using iliac crest bone graft and, if available, local bone graft.

Discussion

Anterior column reconstruction is essential in the treatment of lumbar vertebral body destruction secondary to tumors or infections.[1] The unique anatomy of the lumbar spinal nerve roots has made circumferential decompressions and fusions via a lateral extracavitary approach technically difficult. The most arduous part of this operation is the anterior column reconstruction. Unlike in the thoracic spine, the lumbar nerve roots cannot be sacrificed without the potential for significant lower extremity weakness. Historically, cadaveric allograft shaped from tibia or femur was used. However, the exiting nerve roots created a limited working space making this mode of reconstruction extremely difficult. Fortunately, advances in expandable cage technology have made it easier to reconstruct the anterior column while minimizing the retraction along the lumbar nerve root. In our series, we have demonstrated that it is technically feasible to perform a thorough lumbar corpectomy and anterior column reconstruction in both the upper and lower lumbar spine in both settings of infection and tumor.

Surgeons have criticized the lateral extracavitary approach citing difficulties with visualization and bleeding from the corpectomy site.[2,10] We have found that from a unilateral approach, the contralateral vertebral body wall can be clearly visualized. The key to visualization is a meticulous subperiosteal dissection along the lateral vertebral body wall such that the paraspinal muscles can be completely reflected. Once the majority of the lateral vertebral wall is exposed, this cortical rim can be taken down expeditiously with a rongeur and/or high-speed burr. We have found that leaving the dorsal cortex of the vertebral body intact until the final stages of decompression limits bleeding from the epidural veins. We recommend a bilateral approach only in those situations that necessitate a complete removal of the contralateral vertebral body edge, such as in a solitary metastasis or primary malignancy. Leaving the contralateral pedicle, transverse process, and vertebral body wall intact in the majority of cases provides an increased osseous surface for bony fusion to occur.

Limitations of this technique are balanced by the complications associated with an anterior abdominal or retroperitoneal approach.[7] In the majority of these clinical situations, patients are afflicted by other medical comorbidities and the added insult of an anterior and posterior surgery should not be underestimated. Unquestionably, the primary disadvantage of anterior approach in the majority of situations is the need for a staged posterior spinal reconstruction.[1,3,6,8,12,14] McDonnell and colleagues[15] reported that an anterior and posterior procedure performed under the same anesthetic was a significant risk factor for the occurrence of a major complication in anterior spine surgery. Furthermore, in a review of 1223 anterior spinal fusions, Faciszewski and colleagues[16] reported an 11.5% rate of complications solely attributable to the anterior approach.

It has been previously documented that posterior decompressions can be safely accomplished and obviate the complications associated with an anterior approach.[8,10,17] The difficulty has been primarily in the reconstruction of the anterior column. With the advent of expandable cage technology, anterior reconstruction in the lumbar spine via a lateral extracavitary approach has become technically feasible.[11] In the past, allograft mode reconstruction was the only option limiting the ability to perform an all posterior decompression and reconstruction in many cases. The reduction in operative time and the avoidance of a staged anterior procedure are all tremendous advantages. We believe that the learning curve for a lateral extracavitary decompression and reconstruction is short and can tremendously help reduce patient morbidity and improve clinical outcomes. A single-staged, lumbar extracavitary corpectomy and circumferential reconstruction should be a part of every spine surgeon's armamentarium.

Authors' Disclosure Statement

Dr. Singh is a Consultant for Depuy, Zimmer, and Stryker. He also receives royalties from Zimmer, Stryker, Lippincott and Thieme. Dr. Park reports no disclosures.

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