



## Original Article

# Spinal cord decompression: an endoscopically assisted approach for metastatic tumors

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**Study design:** The paper describes a technique for complete vertebrectomy and spinal cord decompression, followed by a formal anterior column reconstruction, using endoscopic instruments. This procedure is indicated for patients with radioresistant metastasis of the thoracic spine, particularly those involving the upper thoracic segments where a thoracotomy is difficult and carries a high morbidity, and for patients with pulmonary disease who cannot tolerate a standard thoracotomy. Results in nine consecutive cases are reported.

**Objectives:** To demonstrate the feasibility and benefits of endoscopically assisted decompression and stabilization through a single, extrapleural, posterolateral approach.

**Setting:** The Cleveland Clinic, Cleveland, Ohio, USA.

**Methods:** Posterolateral decompression of the thoracic spinal cord offers potential advantages over traditional combined procedures (anterior thoracotomy and posterior instrumentation), including reduced operative time, decreased morbidity, and reduced hospital stay. Previous studies have not demonstrated the same neurological benefit for posterolateral decompression as for anterior vertebrectomy and decompression, however, Surgical indications, rationale and technique for an improved posterolateral approach, augmented by endoscopic methods, are provided, and initial clinical results are described.

**Results:** Drawbacks to the traditional posterolateral decompressions have included poor visualization of the spinal cord and anterior tumor, poor access to tumor on the side contralateral to the approach, and the need to manipulate the spinal cord to completely remove both adjacent tumor and tumor adherent to the dura. Transpedicular decompression using endoscopy is described in nine patients. The mean operative time for the combined procedure was 6.0 h, with a mean blood loss of 1677 cc. Neurological recovery and maintenance were excellent. Inpatient days averaged 6.5, and ICU days averaged 1.4. Two patients died of disease eight and 14 months post-op, and seven were living, with disease, 3–36 months after surgery.

**Conclusions:** Endoscopically assisted decompression can reduce morbidity, hospitalization, and treatment costs while matching the efficacy of traditional combined procedures. Endoscopy provides a readily available and easily applied tool that dramatically improves the surgeon's vision, providing light, magnification, and a direct view of remote structures.

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**Keywords:** spine; tumors; posterolateral approach; decompression; endoscopy

## Introduction

As many as 85% of carcinoma patients eventually develop skeletal metastasis, and the spinal column is the most common site of dissemination.<sup>1–4</sup> As longevity improves, more and more cancer patients will have to deal with symptomatic spinal column disease.

Although most spinal lesions respond well to radiotherapy, radioresistant tumors and those producing bony compromise often require direct surgical decompression. These lesions are usually anterior, and produce both anterior spinal instability and collapse, and anterior cord compression. Laminectomy is usually not beneficial, and anterior decompression is indicated to correct the mechanical and the neurological problem.<sup>5–17</sup> Traditional posterolateral decompression has shown no better results than stabilization alone.<sup>18,19</sup>

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While anterior decompression remains the standard for direct cord decompression, the traditional thoracotomy necessary for thoracic vertebrectomy carries a significant morbidity, and may be quite dangerous for some patients. In the upper thoracic spine, the surgery can be challenging in the best of circumstances. Patients with advanced pulmonary disease and limited pulmonary reserve may not tolerate either the thoracotomy or the temporary loss of lung capacity associated with the procedure. The attempt to accomplish the spinal cord decompression through a posterior approach in these patients is rational. The primary impediments to decompression through a traditional posterolateral approach are limited vision and inability to remove vertebral elements anterior to the spinal cord without blind manipulation of the cord.

Using readily available endoscopic instruments, familiar to most orthopaedists or endoscopists, subtotal and total vertebrectomy and anterior reconstruction have been carried out by the author, with a dramatic reduction in Intensive Care Unit and inpatient hospitalization. An excellent clinical outcome has been achieved, with full restoration or maintenance of spinal cord function in every case. Although not difficult, this posterolateral technique has not been widely reported, and is presented here as an alternative to combined procedures in the upper thoracic spine and in patients with advanced pulmonary disease or systemic illness.

## Methods

### *Preoperative evaluation*

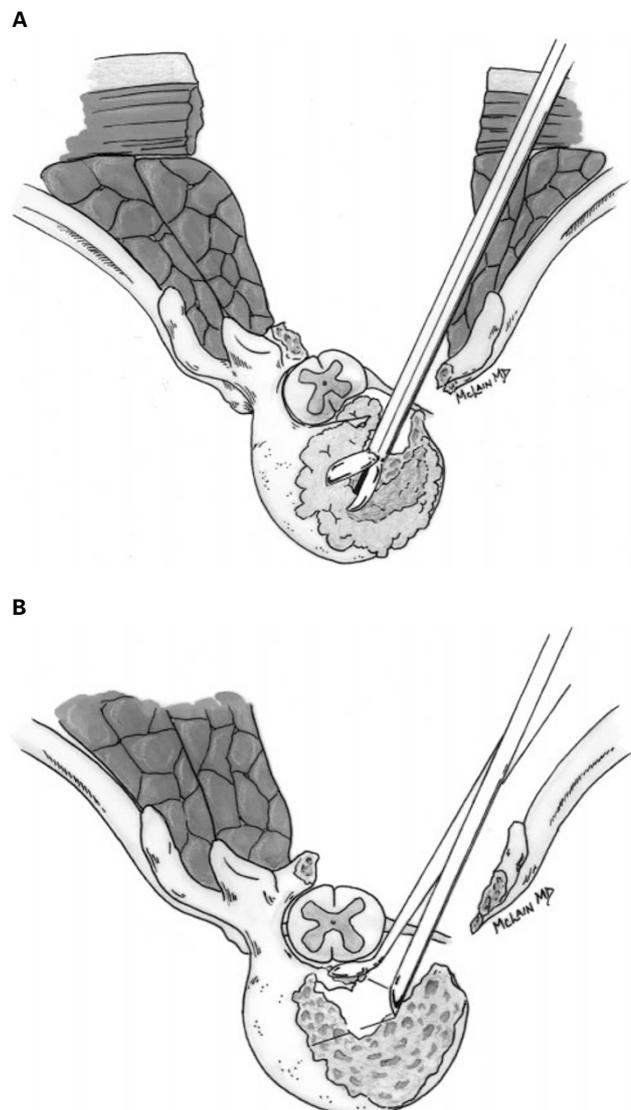
Patients presenting with thoracic spinal metastases underwent a routine battery of tests to determine their medical status, the extent of their disease, and the appropriateness of surgery.<sup>20</sup> Patients indicated for surgical treatment included those who with radio-resistant tumors such as renal cell carcinoma, those who have failed previous radiotherapy, patients with bony compression of the neural elements, and those with segmental instability. Most patients indicated for surgery are further evaluated with angiography and embolization. Patients with potentially vascular lesions such as renal cell carcinoma may undergo two courses of embolization prior to surgical treatment.

The posterolateral decompression described here is by definition an intralaminar resection, appropriate for patients with solitary spinal metastases that are threatening either neurologic function or spinal stability, patients with radioresistant tumors likely to progress to collapse or neurological compromise, and for some patients with radiosensitive tumors such as solitary plasmacytoma where decompression and stabilization are indicated prior to radiation therapy.<sup>21,22</sup> If the tumor is located above T-5, the posterolateral approach avoids the difficulty and potential morbidity of either thoracotomy, or sterno-

clavicular or sternotomy approaches. In these patients, and those with pulmonary disease or pulmonary metastases who cannot tolerate thoracotomy and hypoventilation, the posterolateral approach offers potential advantages.

### *Surgical technique*

The patient is placed prone on the operating table on longitudinal bolsters or a Wilson frame, taking care to support the thoracic kyphosis. A longitudinal mid-line incision is made, and the posterolateral approach is

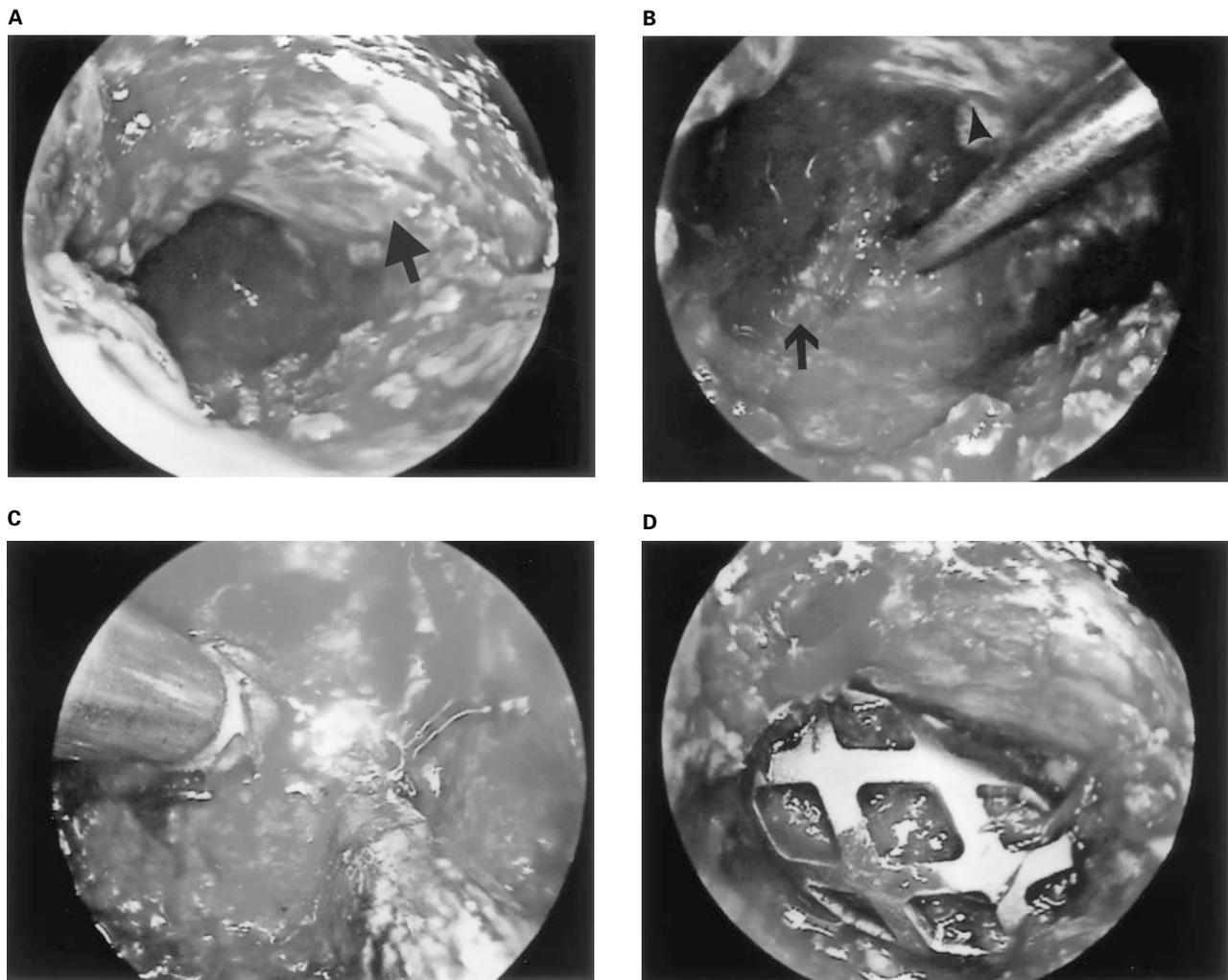


**Figure 1** (A) After removing the pedicle and medial rib, tumor and cancellous bone are removed under direct vision as far as the middle of the vertebral body, creating a cavity. (B) After introducing the endoscope the posterior vertebral cortex is removed under endoscopic visualization. The scope provides an excellent view of the posterior cortex, the posterior longitudinal ligament, and, after debridement, of the PLL itself

carried out.<sup>23</sup> The proximal origin of the rib and any rib invaded by tumor is taken in a standard costotransversectomy approach and the pedicle is then taken down to the back of the vertebral body using a standard transpedicular approach. The surgeon can then debulk the anterior tumor under direct visualization until a cavity is formed in the vertebral body (Figure 1A). Maintaining suction in the base of the vertebral cavity, and irrigating frequently, a 4 mm endoscope is introduced into the cavity. The 30 degree scope is used initially, providing light, magnification, and endoscopic visualization of the posterior vertebral cortex and the tumor and bone immediately anterior to the spinal cord. Reverse angled curettes and angled pituitary rongeurs are used to remove soft tissue and

bone fragments from in front of the cord. The 30 degree scope allows direct examination of the interval between the posterior longitudinal ligament and the posterior cortex (Figure 1B), and developing this interval under endoscopic control allows the surgeon to collapse the posterior cortex into the vertebral cavity without touching the spinal cord. The remaining vertebral body is removed across to the far pedicle using a burr and rongeurs as necessary.

Using a 70 degree scope, the posterior longitudinal ligament and dura can be visualized endoscopically from below; areas of residual compression are seen and addressed and any adherent tumor can be meticulously dissected away from the dura (Figure 2A–D). Epidural veins can be visualized and con-

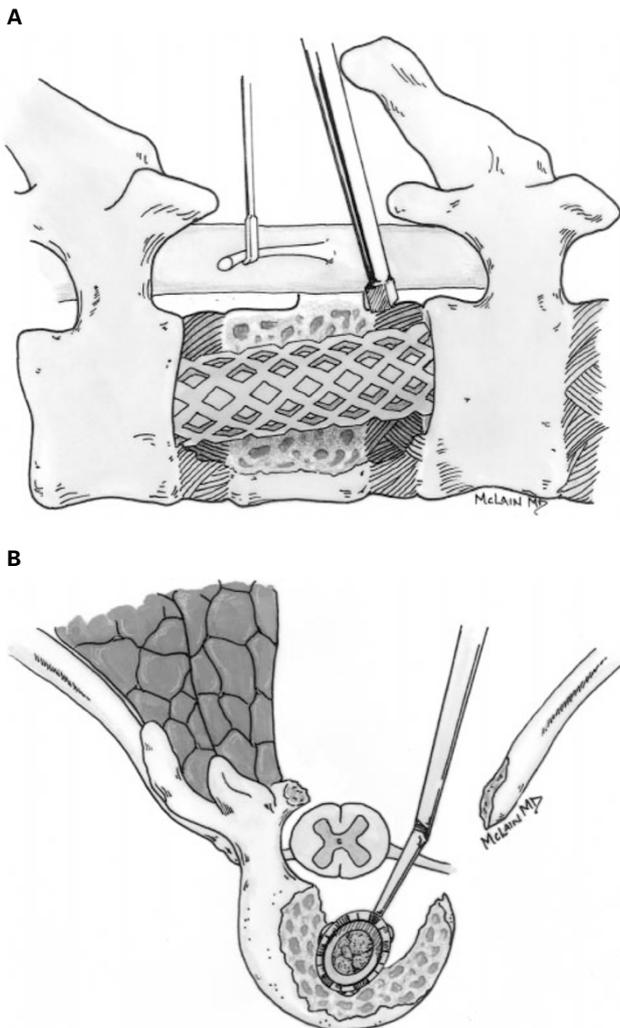


**Figure 2** (A) Endoscopic view after removal of pedicle and cavitation of vertebral body. Spinal cord (arrow) is decompressed dorsally and laterally, and all remaining work will be carried out through the posterolateral portal created between the nerve roots. (B) The endoscope has been advanced into the vertebral cavity. The volar surface of the thecal sac is seen at the top of the image (arrowhead). A suction tip has been introduced just caudal to a band of cartilagenous tissue representing the residual endplate and disc of the diseased vertebral body, (arrow). (C) Under endoscopic visualization a high-speed burr delicately removes the remaining vertebral bone across to the far pedicle. The spinal cord is directly dorsal to the burr. (D) The reconstruction cage, packed with the patient's bone, has been inserted and locked in final position. A free interval between the cage and the cord is confirmed by endoscopy

trolled with an angled bipolar cautery. If the tumor involves the far pedicle, a bilateral approach can be used, otherwise the contralateral pedicle and lamina remain intact for posterior grafting and fusion.

After completing the decompression, the end plates of the adjacent vertebrae are cleared of all soft and cartilaginous tissues and prepared for strut graft reconstruction.

A titanium cage with autograft bone is impacted into place while the cord is viewed through the 70 degree scope (Figure 3). Posterior instrumentation is applied, gently compressing the strut. The wound is closed and a chest x-ray is obtained in the operating room to determine whether a chest tube is needed.



**Figure 3** (A) The cranial and caudal endplates are debrided of all cartilaginous tissue using currettes or burrs. The cage is aligned in the center of the vertebral bodies above and below the decompression. (B) The ipsilateral nerve root is gently retracted cranially or caudally to allow cage placement. The inferior margin of the cage is positioned first, and the superior margin is impacted into place with gentle distraction of the interspace

## Results

Preliminary experience in nine patients with neoplastic disease of the thoracic spine has been reviewed (Table 1). In six patients the ability to avoid a transsternal or transthoracic thoracotomy significantly reduced the postoperative ICU stay and length of postoperative intubation. In three other patients with pulmonary disease the ability to avoid the thoracotomy reduced pulmonary complications and the need for postoperative ventilator support. The mean operative time for the combined procedure was 6.5 h, with a mean blood loss of 1677 cc.

Neurological recovery and maintenance were excellent in each case, with all patients returning to or maintaining normal strength and function. Six of nine patients presented with a measurable neurological deficit prior to surgery. All six recovered completely. All nine patients maintained normal sensation, normal bowel and bladder function and independent ambulation at last follow up or up to the time of terminal care. Inpatient days averaged 6.4, and ICU days averaged 1.4 per patient (range 0–4). At last follow-up two patients had died of disease 8 and 14 months post-op, and seven were living, with disease, 3–36 months after surgery.

## Discussion

Anterior vertebrectomy has effectively replaced laminectomy as the first choice for spinal cord decompression, and has successfully treated cord compression caused by fracture, infection, and spinal tumors.<sup>5,24,25</sup> Typically, laminectomy provides no greater benefit to patients with cord compression than radiotherapy alone,<sup>26,27</sup> and the potential for complications is great.<sup>28,29</sup> Gilbert showed little difference between patients treated with radiotherapy alone and those treated with both laminectomy and radiation.<sup>6,30</sup> The proportion of satisfactory outcomes was less than 50% in either case. The proportion of satisfactory outcomes was less than 50% in either case. Of 427 patients with spinal tumor treated by anterior decompression, 79% had a significant improvement in functional grade and 77% obtained a satisfactory outcome— independent ambulation and intact autonomic function.<sup>12</sup> In contrast, only 38% of 746 patients undergoing posterior decompression had a satisfactory neurologic outcome, and fewer of those with a severe deficit showed significant improvement. In a prospective study of surgical decompression for spinal tumors, Siegal and Siegal<sup>31</sup> performed an anterior decompression for lesions located ventral to the cord and a posterior laminectomy for lesions located dorsally. Only 40% of the laminectomy patients retained or regained the ability to walk, as opposed to 80% of the vertebrectomy patients.

In some cases, improved survival parallels improved neurological recovery. Patients undergoing complete anterior resection of renal tumors had a 37% survival

**Table 1** Preliminary results in five patients treated exclusively through the posterolateral approach

Patient	Tumor type	Level	Initial Frankel grade	Final Frankel grade	Pain at last f/up	Status
T.D.	Solitary renal	T12	C	E	Mild BP (1)	Independent, NED (2)
G.W.	Colon met, + pulm disease	T10	E	E	Mod BP	Independent, LWD
S.K.	Sol plasm	T3	B	E	No pain	Independent, LWD
L.P.	Breast met	T3	D	E	Mild BP	Independent, LWD
J.B.	Colon met	T3	C	E	No pain	DOD at 8 months
OR	Breast met	T5	E	E	No pain	Independent, LWD 18 months
KAA	ABC-pediatric	T10	E	E	No pain	Independent, SP recurrence in rt rib at 12 months
GI	Ca unknown primary + pulm disease	T9	D	E	No pain	DOD at 14 months
AR	Breast CA	T4	D	E	Mild BP	Independent, LWD

1. BP=back pain; 2. NED=No evidence of disease; LWD=Living with disease; DOD=Died of disease

at 2 years while none of those treated with radiotherapy alone survived two years.<sup>16,32</sup> 70% of surgical patients had significant neurologic improvement compared to 45% of radiated patients. Other authors have reported survival rates of 30% or more at five years following aggressive resection of solitary renal metastases.<sup>33</sup>

Traditional thoracotomy has drawbacks, however, including increased operative time, incisional pain, and risks of great vessel injury and hemorrhage. Moreover, in order to visualize the anterior spinal column one lung must be collapsed, resulting in hypoventilation and stress that patients with underlying pulmonary disease or metastasis may not tolerate.

While it may avoid the risks of formal thoracotomy, the results of costotransversectomy and posterolateral decompression have not been as good as with the anterior approach.<sup>5,34,35</sup> Bridwell *et al*<sup>18</sup> reported good short-term results in a series of 25 metastatic lesions, but recommended a formal anterior resection in patients with a life expectancy greater than 1 year. In that series, additional surgery was most often needed because of regrowth of the tumor after incomplete resection.

Patients undergoing traditional anterior and posterior approaches for high thoracic metastases have typically required 2 to 5 days in the intensive care unit and 7 to 15 days of overall hospitalization.<sup>36</sup> Complication rates are high in these compromised patients and prolonged hospitalization is common. Patients undergoing endoscopically assisted decompression have required 36 h in the intensive care unit and 5 to 7 inpatient hospital days on average, and these values, as well as blood loss and surgical time, have continued to improve with experience. In this still small group, neurologic recovery and maintenance, and structural stabilization, are comparable to that seen with combined anterior and posterior approaches. No local recurrence of the tumor has been seen, though one recurrence in an adjacent rib has been noted.

The ability to reduce morbidity, hospitalization, and costs while matching the efficacy of traditional anterior and posterior procedures makes the endoscopic posterolateral approach a valuable treatment option. This technique does not change the underlying prognosis in most cases, or alter the course of systemic disease, but it can protect neurological function and reduce spinal pain. The inability of previous authors to demonstrate efficacy with the posterolateral approach has been due, at least in part, to the inability to completely decompress the neural elements without manipulating the cord.<sup>19</sup> Endoscopy provides a readily available and easily applied tool to dramatically improve the surgeon's vision, providing light, magnification, and a direct view of remote structures.

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