ROBERT F. McLAIN, MD
Staff surgeon, Department of Orthopaedic Surgery, Cleveland Clinic

GORDON R. BELL, MD
Head, Section of Spinal Surgery, Department of Orthopaedic Surgery, Cleveland Clinic

Newer management options in patients with spinal metastasis

ABSTRACT

For some patients with spinal metastasis and spinal cord compression, newer surgical techniques are better than laminectomy or radiotherapy alone in relieving pain and restoring function. While radiotherapy remains the standard for spinal metastases due to myeloma, lymphoma, and many types of adenocarcinoma, proper surgical treatment can significantly improve function and outcome in selected patients.

KEY POINTS

About 95% of clinically important spinal tumors are metastatic, and 60% arise from myelomas, lymphomas, and adenocarcinomas of the breast, lung, and prostate.

While 70% of ambulatory patients remain ambulatory after radiation therapy, patients who have lost the ability to walk rarely regain it through radiotherapy alone.

Surgery is indicated for some biopsies, treating mechanical instability, and decompressing the spinal cord in cases of bony impingement, failed radiotherapy, or tumors resistant to radiotherapy.

FOR SOME PATIENTS with spinal metastasis, appropriate surgical management can improve function immediately and prolong survival.

Unfortunately, many physicians are reluctant to recommend surgery for spinal metastasis. To spare a patient from an invasive procedure, they may choose to exhaust all medical treatments before considering surgical consultation and may miss the window of opportunity for successful surgical treatment. Others may distrust newer surgical techniques in favor of older techniques, such as laminectomy, which requires prolonged bed rest afterward.

This is unfortunate. As cancer patients live longer thanks to improved medical and adjunctive therapies, spinal metastasis poses a greater threat to their independence and survival. Technical improvements are making aggressive surgery for spinal metastasis much less risky. Alternate approaches (TABLE 1) provide the neurologic and mechanical benefits afforded by traditional surgical techniques, but with more rapid recovery and reduced morbidity. In addition, newer surgical techniques often eliminate the need for bed rest and have largely replaced laminectomy as a treatment option.[1] Therefore, surgical management should not be dismissed without consideration.

NOT ALL TUMORS RESPOND TO RADIATION

About 95% of clinically important spinal tumors are metastatic, and 60% arise from myelomas, lymphomas, and adenocarcinomas of the breast, lung, and prostate.[2–5] These

TABLE 1

Glossary of surgical options

Trocar biopsy
Percutaneous surgical biopsy, recommended when needle biopsy fails to provide a diagnosis. May require local or general anesthesia.

Laminectomy
Removal of lamina and posterior elements covering the spinal cord, in an effort to relieve pressure on the cord. Less than 50% success rate in tumor patients. Significant risk of neurologic injury, wound complications.

Anterior decompression with vertebrectomy
Removal of the vertebral body through either thoracotomy or laparotomy. The definitive surgical treatment for spinal cord decompression. More difficult approach, but 85% success rate in spinal tumors, less blood loss and fewer neurologic complications than laminectomy.

Posterolateral decompression
An alternative approach to the vertebral body, using a posterior incision. Access is gained by going around the side of the body, removing the head of the rib or the vertebral pedicle. Complete decompression is difficult without endoscopic control.

Spinal fixation
Combinations of hooks and pedicle screws allow surgeons to fix rigid rods to the posterior elements of the spinal column. These function as an internal splint, allowing the patient to sit up and ambulate immediately after surgery, and eliminating the need for body casts or prolonged bed rest.

tumors typically respond to radiation therapy, which rapidly and reliably relieves pain and neural compression in most patients.[5–7] For example, most patients with adenocarcinoma eventually develop spinal metastases, yet fewer than half develop a clinically significant lesion. Most of these respond to radiation therapy, and surgical treatment provides no added benefit.

However, not all patients have the same response. For example, although breast cancer metastases usually respond to radiation treatment, as many as 30% do not demonstrate a clinical response to radiation therapy alone.[8] Furthermore, while 70% of ambulatory patients remain ambulatory after radiation therapy, patients who have lost the ability to walk rarely regain it through radiotherapy alone.[7]

WHEN IS SURGERY INDICATED?

Surgery may prove necessary if:

- Workup and needle biopsy fail to provide a diagnosis.
- Mechanical instability (fracture, collapse) causes pain and progressive deformity.
- Pathological fracture causes bone fragments to compress the spinal cord or nerve roots.
- A symptomatic tumor is known to be resistant to radiation therapy.
- A spinal tumor continues to progress in spite of adequate radiation therapy.

TYPES OF SPINAL SURGERY

There are three types of spinal surgical procedures: biopsy, stabilization, and decompression.

Biopsy of spinal metastases

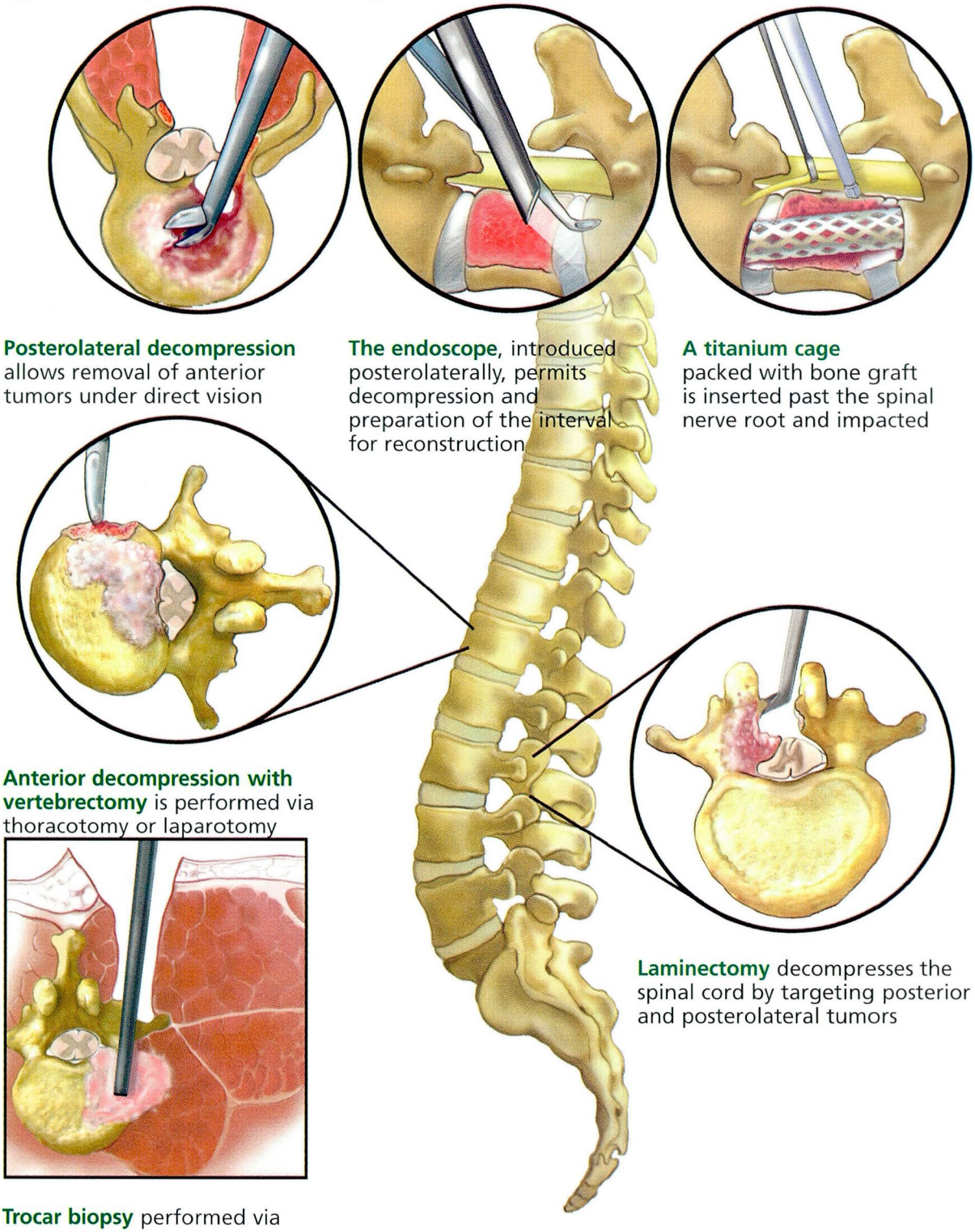
Whenever there is doubt about the tumor's origin, biopsy should be performed. For patients with metastatic disease, biopsy is often the only surgical procedure needed. Patients with a previously documented primary lesion or with metastatic lesions at sites more accessible to needle biopsy may not require spinal surgery. As long as there is no neurologic encroachment or mechanical instability, radiation therapy can usually halt tumor progression and relieve pain. However, if biopsy reveals a lesion resistant to radiation therapy, or if the patient is at risk of fracture, vertebral collapse, or neurologic symptoms (or has already experienced these events), then surgical stabilization with or without decompression may be needed in addition to biopsy.

If needle biopsy fails to obtain diagnostic material, trocar biopsy can be performed through a small posterior incision via a transpedicular approach (FIGURE 1).

Surgical stabilization of the spine

As a tumor expands, it disrupts bone and soft-tissue structures that maintain normal spinal alignment and resist the loads occurring during daily activities. The diseased vertebra may collapse or shift out of alignment with adjacent vertebrae, resulting in severe pain and spinal cord injury.

Surgical options for spinal metastasis



Posterolateral decompression allows removal of anterior tumors under direct vision

The endoscope, introduced posterolaterally, permits decompression and preparation of the interval for reconstruction

A titanium cage packed with bone graft is inserted past the spinal nerve root and impacted

Anterior decompression with vertebrectomy is performed via thoracotomy or laparotomy

Laminectomy decompresses the spinal cord by targeting posterior and posterolateral tumors

Trocar biopsy performed via a posterior approach

FIGURE 1

Most cancer patients with mild mechanical instability and neck or back pain can be successfully treated nonsurgically with bracing and radiation therapy. But if bone destruction becomes advanced, surgical stabilization may be necessary either to hold the spine in place until radiotherapy can have an effect, or to replace the damaged structures.

If the tumor is a type that typically responds to radiation therapy and the spinal alignment is acceptable, the spine can be stabilized posteriorly with rods and hooks before starting radiotherapy. If the tumor is a type that typically does not respond to radiation therapy, or if bone destruction is advanced, the vertebral body may need to be removed and replaced with a bone graft or titanium cage to restore the alignment and strength of the spinal column.[9,10]

Patients in whom instability is likely to develop in spite of radiotherapy should undergo surgical stabilization *before* starting radiotherapy to maintain spinal alignment and to minimize wound complications. According to Kostuik et al,[11] patients with thoracolumbar lesions (T10 to L2) that are lytic (bone-destroying) in appearance and that involve three or more of six transverse zones (FIGURE 2) are at high risk for fracture either during or after radiation therapy and should undergo surgical stabilization prophylactically. Lesions in the upper thoracic or lower lumbar regions, and with a blastic (bone-forming) or mixed radiographic picture, are much less likely to collapse.

New fixation systems allow the patient out of bed the next day

Segmental spinal fixation. Current systems use hooks and screws to attach rods to the posterior spine at multiple vertebral levels (FIGURE 1). This *segmental* fixation system distributes the forces of fixation to multiple points along the spine and decreases the likelihood of rod or hook failure. Segmental systems stabilize the spine immediately and allow the patient to get out of bed on the first postoperative day. They also resist bending and twisting better than first-generation rod systems and eliminate the need for prolonged bed rest or a cumbersome cast. These implants are now available in titanium, which improves postoperative imaging capabilities because it does not interfere with magnetic resonance and computed tomography imaging the way stainless steel does.

Spinal decompression

As many as 20% of all patients with disseminated carcinoma develop symptomatic compression of the spinal cord or cauda equina.[12–14] Compression can result either from encroachment by an enlarging soft tissue mass, or from a pathological fracture with extrusion of bone fragments into the spinal canal or vertebral collapse and kyphosis. Compression due to tumor mass encroachment usually responds to irradiation, but fracture does not.[4,15]

Early recognition and prevention are crucial: 60% to 95% of cancer patients who are ambulatory at the time of treatment remain ambulatory after treatment, whereas only 35% to 65% of paraparetic patients and less than 30% of paraplegic patients regain ambulation through surgical or medical treatment.[11,16,17]

If the tumor is a type that typically responds to radiotherapy, and neural deterioration has been gradual, then radiotherapy is the treatment of choice. But if progression is rapid, unresponsive to radiotherapy, or secondary to bony compression, then surgery is indicated.

SELECTING THE BEST SURGICAL OPTION FOR SPINAL DECOMPRESSION

Before 1985, the most common method of spinal cord decompression was laminectomy—unroofing the spinal cord and nerve roots from behind (FIGURE 1). Since then, procedures that use approaches from the front or side have become more popular, for the reasons outlined below.

Disadvantages of laminectomy

Laminectomy provides direct access to posterior and posterolateral tumors. However, compression is usually due to tumors in the vertebral body, ie, in front of the spinal cord.[18] Therefore, laminectomy does not reliably relieve symptoms of spinal cord compression and pain. Further, laminectomy compromises the stability of the spine.

In one review of 38 patients undergoing laminectomy,[19] only 24% demonstrated any improvement in neurologic function, and in a series of 27 cases of osteosarcoma of the spine,[20] biopsy combined with laminectomy

provided only transient relief in patients with neurologic deficits. Surgery did not improve survival in these patients. Although Constans et al[12] found some benefit when laminectomy was used with radiotherapy, Gilbert et al[21] found no difference between patients treated with radiotherapy alone and those treated with laminectomy and radiation. The proportion of satisfactory outcomes was less than 50% in either case.

Patients with anterior cord compression are more likely to suffer a spinal cord injury or neurologic deterioration when laminectomy is selected as the primary treatment. If the cord is manipulated in an effort to reach anterior tumor tissue, the risk of neurologic injury is high, particularly in the thoracic region.[22] Findlay[23] noted a poor rate of recovery and a high incidence of postoperative paraplegia when patients with vertebral collapse were treated with laminectomy. He concluded that laminectomy fails to adequately decompress the spinal cord because vertebral fragments and tumor tissue cannot be removed from the anterior surface of the cord without manipulating the cord and risking neurologic injury.

In another study,[24] only 38% of 746 patients undergoing laminectomy for spinal metastases had a satisfactory neurologic outcome, and in other studies, even fewer of those with a severe preoperative deficit showed improvement.[21,25–30] Although instrumentation improved pain relief and maintenance of neurologic function compared to laminectomy alone, the overall results have still been disappointing.

For these reasons, below the third cervical level, laminectomy should be used only for lesions in the dorsal elements, laminae, and pedicles.[31,32] Most lesions, however, occur in the vertebral body and are most successfully addressed through an anterior approach (see below).[18]

Anterior surgical decompression of the spinal cord

The anterior approach to spinal decompression, widely used since the early 1980s, has been successful in treating cord compression caused by a variety of spinal disorders (FIGURE 1). While an anterior surgical approach may seem aggressive for patients with a systemic disease, this route provides the best neurologic recovery and immediate mechanical stability, offering distinct advantages over other procedures: an 85% success rate for spinal tumors, and less blood loss and fewer neurologic complications than laminectomy.[32–34] Cancer patients who undergo early intervention have the best outcomes.[35]

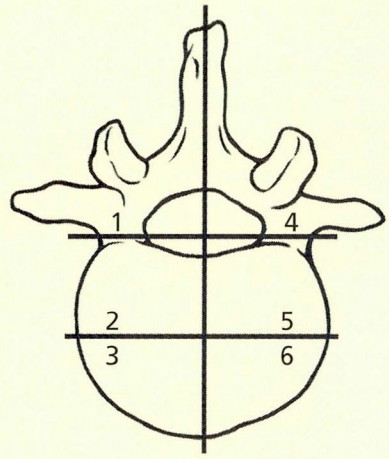


FIGURE 2. If more than three of the six major vertebral zones are disrupted by tumor, then pathological fracture is likely to occur either during or after radiation therapy, unless prophylactically stabilized. Lytic lesions and those in the thoracolumbar region also pose a high risk of vertebral collapse.

Vertebrectomy can provide significant neurologic improvement

The goal of anterior decompression is removal of the vertebral body and all tumor anterior to the spinal cord. This procedure is termed vertebrectomy. Access is gained via thoracotomy or laparotomy. By removing the entire vertebral body, pressure on the spinal cord is completely relieved, providing the best likelihood of neurologic recovery and maintenance. The spinal column must be reconstructed with a graft or cage to prevent collapse, and a second, posterior stabilization procedure is usually needed.

Vertebrectomy can provide significant neurologic improvement in 75% to 95% of patients treated for metastatic disease.[18,32]

Compared with laminectomy and radiotherapy. In a prospective series of patients

needing surgical decompression for metastatic disease, Siegal et al[33,34] performed an anterior vertebrectomy and decompression for lesions anterior to the spinal cord, and laminectomy for posterior lesions. Surgical patients were compared with a second group treated with radiotherapy alone. Only 30% of patients treated with radiotherapy retained or regained the ability to walk, compared with 40% of the laminectomy patients and 80% of the vertebrectomy patients. Five of 25 patients treated with laminectomy actually deteriorated as a result of treatment. The operative mortality was similar for both surgical approaches, but postoperative complications were far more frequent in the laminectomy group, usually because of poor healing of incisions made through irradiated tissue.

In 427 cases of anterior decompression in which objective grading of neurologic recovery was reported,[36] 79% had a significant improvement in functional grade and 77% obtained a satisfactory outcome—independent ambulation and intact bowel and bladder function.[37–47]

Certain types of tumors respond better to surgical resection than to irradiation. Renal cell tumors, for example, demonstrate a highly variable course in terms of survival, but recent studies have shown an improved outcome with surgical resection.[47–49] Sundaresan[47] reported on 43 patients with renal cell carcinoma, 32 undergoing anterior resection for cord compression and 11 undergoing radiation only. The median survival of the surgical group was 13 months, compared with 3 months for those treated with radiation alone. Patients undergoing complete resection of tumor anteriorly had a 37% survival at 2 years, while none of those treated with radiotherapy alone survived 2 years. Significant neurologic improvement was seen in 70% of surgery patients compared with 45% of radiation patients.[50] Other authors have reported 5-year survival rates of 30% after aggressive resection of solitary renal metastases.[51]

The posterolateral approach does not require thoracotomy

Posterolateral approach

In the upper thoracic spine (above T6), the anterior approach is technically challenging, requiring a difficult thoracotomy and prolonged deflation of one lung. The potential complications are serious.

As an alternative to the anterior approach, lesions of the thoracic spine may be accessible via a posterolateral approach. Posterolateral dissection involves removing part of the rib and the lamina to gain access to the vertebral body and decompress the anterior aspect of the spinal cord from the side.[11,25,52]

The goal of posterolateral decompression is to remove the affected vertebrae and adjacent dics, just as in an anterior approach. Posterolateral approaches to spinal cord decompression are performed through the interval between the rib-head and the vertebra (costotransversectomy), or directly down the pedicle (FIGURE 1). These approaches have been used for several years to debulk metastatic spinal tumors, but results have not been as good as with the formal anterior approach.[53] Recent modifications of the costotransversectomy approach have improved patient outcome, but access to the compressive lesion is always limited because the surgeon is working around the spinal cord, and neurologic recovery has still been less reliable than with a formal anterior approach.[52,54]

There are certain advantages to the posterolateral approach that make it useful in physically compromised patients, however. Unlike the anterior approach, the posterolateral approach does not require thoracotomy. Also, posterior spinal instrumentation can be carried out at the same time as tumor removal, but access to the tumor is usually limited. To address this limitation, video-assisted endoscopic techniques (FIGURE 1) have improved tumor resection and facilitated reconstruction in this difficult region. By providing light, magnification, and visualization of tissues usually obscured from the line of sight, endoscopy allows the careful resection of all pathological tissue from the vertebra, and direct decompression of the spinal cord without having to manipulate it.

After completing the vertebrectomy, the surgeon removes the adjacent discs so that a vertical strut can be inserted between the endplates of the healthy vertebrae above and below the tumor site. A strut graft or prefabricated cage is introduced posterolaterally to restore anterior stability and prevent collapse

of the spinal column. The endoscope allows optimal positioning of the reconstructive cage, minimizing the risk of cord impingement. Posterior fixation rods can be placed through the same incision, providing immediate stability. New instrumentation systems allow the patient to sit in a chair the night of surgery and to begin walking the next day.

Preliminary studies[37] have shown that this technique reduces patient morbidity, days in intensive care, and inpatient hospitalization, while providing the same quality of neurologic recovery and maintenance of function as traditional anterior resection.

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ADDRESS: *Robert F. McLain, MD, Department of Orthopaedic Surgery, A41, The Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, OH 44195.*

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