CME CREDIT

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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

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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.

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Surgical options for spinal metastasis

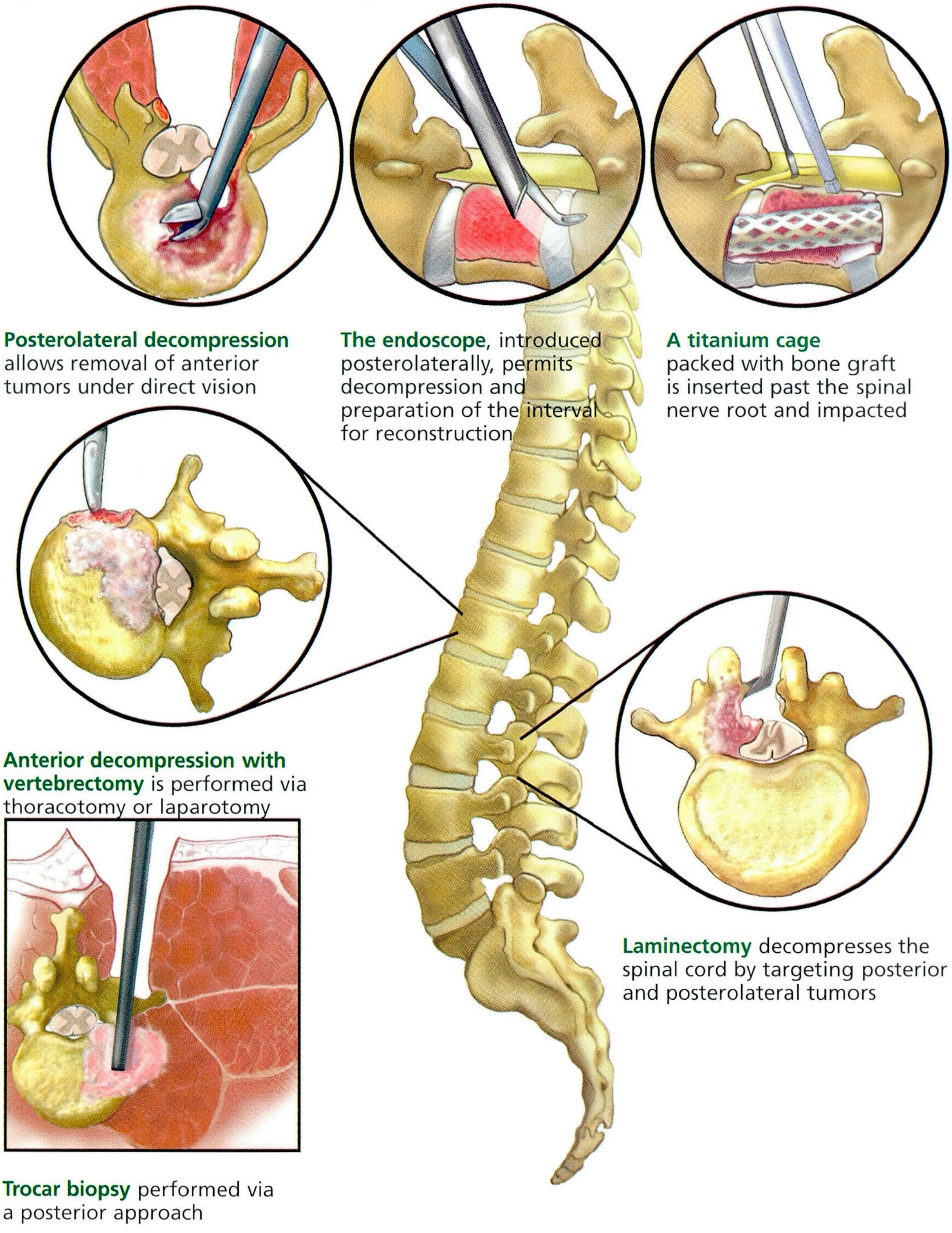

FIGURE 1

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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

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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]

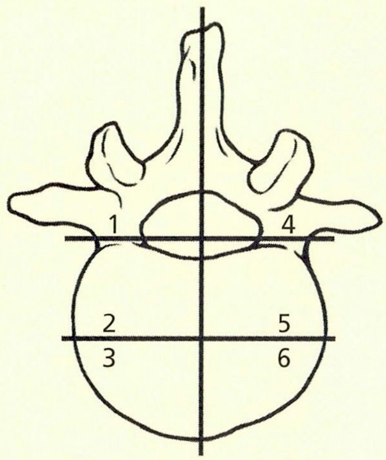

FIGURE 2. If more than three of the six major vertebral zones are disrupted by tumor, then pathological fracture is likely to occur either during or after radiation therapy, unless prophylactically stabilized. Lytic lesions and those in the thoracolumbar region also pose a high risk of vertebral collapse.

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

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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

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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.

REFERENCES

1. **Salmon SE, Cassady JR.** Plasma cell neoplasms. In: DeVita VT, Hellman S, Rosenberg SA (editors). Principles and practice of oncology. New York: Lippincott-Raven, 1996:2344–2365.
2. **Clain A.** Secondary malignant disease of bone. Br J Cancer 1965; 19:15–29.
3. **Graham WD.** Metastatic cancer to bone. In: Graham WD. Bone tumours. London: Butterworths, 1966:94–100.
4. **Harrington KD.** Current concepts review: metastatic disease of the spine. J Bone Joint Surg 1986; 68A:1110–1115.
5. **Millburn L, Hibbs GC, Hendrickson FR.** Treatment of spinal cord compression from metastatic carcinoma. Cancer 1968; 21:447–452.
6. **Bruckman JE, Bloomer WD.** Management of spinal cord compression. Semin Oncol 1978; 5:135–140.
7. **Tomita T, Galicich JH, Sundaresan N.** Radiation therapy for spinal epidural metastases with complete block. Acta Radiol Oncol 1983; 22:135–143.
8. **Greenberg HS, Kim JH, Posner JB.** Epidural spinal cord compression from metastatic tumor. Ann Neurol 1980; 8:361–366.
9. **Bell GR.** Surgical treatment of spinal tumors. Clin Orthop 1997; 335:54–63.
10. **McLain RF, Kabins M, Weinstein JN.** VSP stabilization of lumbar neoplasms: technical considerations and complications. Journal of Spinal Disorders 1991; 4:359–365.
11. **Kostuik JP.** Anterior spinal cord decompression for lesions of the thoracic and lumbar spine, techniques, new methods of internal fixation, results. Spine 1983; 8:512–531.
12. **Constans JP, Divitiis E, Donzelli R, Spaziante R, Meder JF, Haye C.** Spinal metastases with neurological manifestations: review of 600 cases. J Neurosurg 1983; 59:111–118.
13. **Siegal T, Siegal T.** Current considerations in the management of neoplastic spinal cord compression. Spine 1988; 14:223–228.
14. **Wong DA, Fomasier VL, MacNab I.** Spinal metastases: the obvious, the occult, and the impostors. Spine 1990; 15:1–4.
15. **Boland PJ, Lane JM, Sundaresan N.** Metastatic disease of the spine. Clin Orthop 1982; 169:95–102.
16. **Harrington KD.** Anterior decompression and stabilization of the spine as a treatment for vertebral collapse and spinal cord compression from metastatic malignancy. Clin Orthop 1988; 233:177–197.
17. **Leviov M, Dale J, Stein M, et al.** The management of metastatic spinal cord compression: a radiotherapeutic success ceiling. Int J Radiat Oncol Biol Phys 1993; 27:231–234.
18. **Harrington KD.** The use of methylmethacrylate for vertebral-body replacement and anterior stabilization of pathologic fracture-dislocations of the spine due to metastatic malignant disease. J Bone Joint Surg 1981; 63A(1):36–46.
19. **Nicholls PJ, Jarecky TW.** The value of posterior decompression by laminectomy for malignant tumors of the spine. Clin Orthop 1985; 201:210–213.
20. **Shives TC, Dahlin DC, Sim FH, Pritchard DJ, Earle JD.** Osteosarcoma of the spine. J Bone Joint Surg 1986; 68A(5):660–668.
21. **Gilbert RW, Kim JH, Posner JB.** Epidural spinal cord compression from metastatic tumor: diagnosis and treatment. Ann Neurol 1978; 3(1):40–51.
22. **Martin NS, Williamson J.** The role of surgery in the treatment of malignant tumours of the spine. J Bone Joint Surg 1970; 52B(2):227–237.
23. **Findlay GFG.** The role of vertebral body collapse in the management of malignant spinal cord compression. J Neurol Neurosurg Psychiatry 1987; 50:151–154.
24. **Brice J, McKissock W.** Surgical treatment of malignant extradural spinal tumors. British Med J 1965; 1:1341–1344.
25. **Kostuik JP, Errico TJ, Gleason TF, Errico CC.** Spinal stabilization of vertebral column tumors. Spine 1988; 13(3):250–256.
26. **Hall AJ, MacKay NNS.** The results of laminectomy for compression of the cord or cauda equina by extradural malignant tumor. J Bone Joint Surg 1973; 55B(3):497–505.
27. **Nather A, Bose K.** The results of decompression of cord or cauda equina compression from metastatic extradural tumors. Clin Orthop 1982; 169:103–108.
28. **Sherman RMP, Waddell JP.** Laminectomy for metastatic epidural spinal cord tumors. Clin Orthop 1986; 207:55–63.
29. **White WA, Patterson RH, Bergland RM.** Role of surgery in the treatment of spinal cord compression by metastatic neoplasm. Cancer 1971; 27(3):558–561.
30. **Wright RL.** Malignant tumors in the spinal extradural space: results of surgical treatment. Ann Surg 1963; 157(2):227–231.
31. **Fidler MW.** Pathologic fractures of the cervical spine. J Bone Joint Surg 1985; 67B(3):352–357.
32. **Fidler MW.** Anterior decompression and stabilization of metastatic spinal fractures. J Bone Joint Surg 1986; 68B(1):83–90.
33. **Siegal T, Siegal T.** Surgical decompression of anterior and posterior malignant epidural tumors compressing the spinal cord: a prospective study. Neurosurgery 1985; 17(3):424–432.
34. **Siegal T, Tiqva P, Siegal T.** Vertebral body resection for epidural compression by malignant tumors. J Bone Joint Surg 1985; 67A(3):375–382.
35. **Johnson JR, Leatherman KD, Holt RT.** Anterior decompression of the spinal cord for neurologic deficit. Spine 1983; 8(4):396–405.
36. **McLain RF, Weinstein JN.** Tumors of the spine. Seminars in Spine Surgery 1990; 2(3):157–180.
37. **McLain RF.** Endoscopically assisted decompression for metastatic thoracic neoplasms. Spine 1997; 23:1130–1135.
38. **Milch A, Changus GW.** Response of bone to tumor invasion. Cancer 1956; 9(2):340— 351.
39. **Perrin RG, McBroom RJ.** Anterior vs posterior decompression for symptomatic spinal metastasis. Canadian Journal of Neurological Sciences 1987; 14(1):75–80.

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40. **Torma T.** Malignant tumors of the spine and the spinal epidural space: a study based on 250 histologically verified cases. Acta Chir Scand 1957; 225 (Suppl):1–138.
41. **Young RF, Post EM, King GA.** Treatment of spinal epidural metastases. J Neurosurg 1980; 53:741–748.
42. **Harrington KD.** Metastatic disease of the spine. In: Harrington KD. Orthopaedic management of metastatic bone disease, editor. St. Louis: C.V. Mosby Company, 1988; 309–383.
43. **O'Neil J, Gardner V, Armstrong G.** Treatment of tumors of the thoracic and lumbar spinal column. Clin Orthop 1988; 227:103–112.
44. **Manabe S, Tateishi A, Abe M, Ohno T.** Surgical treatment of metastatic tumors of the spine. Spine 1989; 14(1):41–47.
45. **Sundaresan N, Galicich JH, Lane JM, Bains MS, McCormick P.** Treatment of neoplastic epidural cord compression by vertebral body resection and stabilization. J Neurosurg 1985; 63:676–684.
46. **Flatley TJ, Anderson MH, Anast GT.** Spinal instability due to malignant disease. J Bone Joint Surg 1984; 66A(1):47–52.
47. **Sundaresan N, Sachdev VP, Holland JF, et al.** Surgical treatment of spinal cord compression from epidural metastasis. J Clin Oncol 1995; 13:2330–2335.
48. **Saitoh H, Hida M.** Metastatic processes and a potential indication of treatment for metastatic lesions of renal adenocarcinoma. J Urol 1982; 128:916–918.
49. **Skinner DG, Colvin RB.** Diagnosis and management of renal cell carcinoma. Cancer 1971; 28:1165–1177.
50. **Sundaresan N, Scher H, DiGiacinto GV, Yagoda A, Whitmore W, Choi IS.** Surgical treatment of spinal cord compression in kidney cancer. J Clin Oncol 1986; 4:1851–1856.
51. **Tolia MB, Whitmore WR.** Solitary metastasis from renal carcinoma. J Urol 1975; 224:836–838.
52. **Bridwell KH, Jenny AB, Saul T, Rich KM, Grubb RL.** Posterior segmental spinal instrumentation (PSSI) with posterior decompression and debulking for metastatic thoracic and lumbar spinal disease. Spine 1988; 13:1383–1394.
53. **DeWald RL, Bridwell KH, Prodromas C, Rodts MF.** Reconstructive spinal surgery as palliation for metastatic Malignancies of the Spine. Spine 1985; 10(1):21–26.
54. **Overby MC, Rothman AS.** Anterolateral decompression for metastatic epidural spinal cord tumors. J Neurosurg 1985; 62:344–348.

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