Evidence-based review of the surgical management of vertebral column metastatic disease

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Object. Significant controversy exists over the most appropriate treatment for patients with metastatic disease of the vertebral column. Treatment options include surgical intervention, radiotherapy, or a combination of the two; nevertheless, a standard of care that yields the best survival, outcome, and quality of life has not been established. The purpose of this review was to determine the foundation in the literature of views favoring surgical intervention for spinal metastatic disease.

Methods. A search of the English-language literature published between 1964 and 2003 was performed for the subject of spinal metastatic disease. Papers were selected based on the inclusion criteria described, and evidentiary information was compiled and graded using previously described methods.

Conclusions. Although there is insufficient evidence to support a standard for surgical treatment in patients with metastatic spinal disease, the authors present guidelines and recommendations based on the evidence provided by the current literature.

KEY WORDS • spinal cord compression • cancer • metastasis • radiation therapy • evidence-based medicine

The spinal column is the most frequent site of bone metastasis.^{1,44} Metastatic spinal disease is a significant problem for a large number of patients: spinal metastases develop in between 5 and 10% of all patients with cancer during the course of their disease.⁷ Approximately 40% of persons dying of cancer have autopsy evidence of spinal metastases;^{2,7,28} 10% of these will experience spinal cord compression with subsequent neurological deficits.^{47,55} The annual incidence of spinal cord compression due to spinal metastases is estimated to be 20,000 cases.¹⁶ In recent autopsy studies, investigators found metastatic involvement of the spine in 90% of patients with prostate carcinoma, in 75% of those with breast carcinoma, 55% of those with melanoma, 45% of those with lung carcinoma, and 30% of those with renal carcinoma.^{32,56,67} Specific carcinomas cause clinically significant spinal cord compression in a higher percentage of patients. Twenty-two percent of patients with breast cancer, 15% of those with lung cancer, and 10% of those with prostate carcinomas experience symptomatic spinal cord compression.⁵⁶

There is a slight preponderance of metastatic tumors in male (60%) compared with female patients.¹⁵ This sex dif-

ference may reflect the incidence of primary breast lesions compared with prostate tumors in published series. All ages of patients may be affected, but the period of highest prevalence coincides with the relatively high cancer risk period that occurs between 40 and 65 years of age.⁹

Metastatic spinal lesions involve the vertebral column and pedicle (85%), the paravertebral spaces (10–15%), or the epidural space.^{11,23} The junction of the vertebral body and pedicle is usually the portion of the vertebra involved with metastasis.^{11,42} Metastatic spread to bone may be related to osteotropism of the malignant cells, direct spread, and the highly vascular supply to bone marrow.¹ Seventy percent of cases occur at the thoracic level, 20% at the lumbar region, and 10% at the cervical region.²³ Increased frequency of spinal metastases at the thoracic vertebrae may be related to the fact that there are more thoracic vertebrae than lumbar and cervical ones. Metastatic lesions present initially at multiple, noncontiguous levels in 10 to 38% of cases.^{23,39,45}

The incidence of metastatic spinal disease is likely to increase in the future. Improvement in diagnostic capabilities, especially the widespread availability and sensitivity

of magnetic resonance imaging, may increase the number of patients evaluated and metastatic lesions detected. Progress in many multimodality cancer treatments will prolong patient survival, resulting in more spinal metastases. Screening programs yielding earlier detection of malignant primary lesions will lead to identification of an ever-increasing number of spinal metastases.

Standard treatments for metastatic spinal tumors include radiotherapy alone, radiotherapy plus systemic chemotherapy, hormone therapy, surgical decompression followed by radiotherapy, and, more recently, extracranial radiosurgery.^{21,46} When a metastatic spinal tumor causes compression of the spinal cord or other neural elements, surgical decompression is often chosen. Based on the extent of spinal column destruction and the resulting biomechanical instability of the spine, fixation may be elected. The goal of local radiation therapy in the treatment of spinal metastases has been palliation of painful symptoms, prevention of pathological fractures of the vertebral body, and halting or reversing progression of neurological compromise. The role of radiosurgery has yet to be defined but will likely be limited to treatment of focal disease or use as a supplement to fractionated radiotherapy.

In this evidence-based review we will examine the basis for current clinical practice, focusing on the role of surgery in the management of metastatic spinal column disease.

Rationale for the Study

Metastatic spinal column tumors occur with sufficient frequency to warrant review. The role of surgery in the therapeutic management of vertebral column metastatic disease remains controversial. In 1998, the Canadian Task Force on the Periodic Health Examination produced an evidence-based guideline review of the literature.³³ At the time, the authors concluded that very few papers of high methodological quality had been published, and that more studies were needed to verify the validity of many of the clinical decisions regarding the management of this disease process.

For this review, medical literature addressing surgical management of vertebral column metastatic lesions was examined using the methods of evidence-based medicine to address the following question: "What is the role of surgical management of vertebral column metastatic disease?"

SEARCH METHODS

The database of the National Library of Medicine was searched using the PubMed search engine. The key words "spine" and "metastasis" were used, with limiting factors of "human" and "English language." All articles dating from 1964 through August 2003 were included in the final review; this search produced 1178 articles. Titles and abstracts were then reviewed, and only articles addressing surgical management of spinal metastases were retained. Papers that primarily analyzed the nonoperative treatment of spinal metastases were excluded in the evidentiary table. The bibliographies of included papers were also examined to assess the completeness of the literature review. Additional papers identified from these bibliogra-

phies that contained relevant supporting information were then included. This yielded a total of 46 articles, which are summarized in Table 1. Additionally, we were aware of an abstract presented at the 39th Annual Meeting of the American Society of Clinical Oncology by Patchell, et al.⁴⁰ Although this cannot be included in the evidentiary tables until it is published, it is noted in the *Discussion* and *References* sections.

Scientific Foundation

The annual incidence of spinal cord compression caused by spinal metastases is estimated to be 20,000 cases.¹⁶ As discussed, the incidence of metastatic spinal disease is likely to increase in the future. In one evidence-based guideline review of the literature, researchers found that current surgical recommendations are based on inconclusive evidence.³³ Surgery may be considered a first-line treatment for ambulatory patients presenting with spinal instability, bone compression, or paraplegia. Our review focuses on the most significant articles identified in the literature search. The author and year of publication, a description of the study, a data class, and a conclusion is provided for each paper in Table 1.

Classification of Evidence

When assessing the value of therapies or interventions, the available data are classified into one of three categories according to the criteria established in the guidelines for the management of acute cervical spine and spinal cord injuries.⁴

RESULTS

Currently, there is only one Class I study available in the peer-reviewed literature.⁶⁹ This study shows no significant outcome difference when comparing 16 patients who underwent laminectomy followed by radiation with 13 patients who underwent radiation alone. This study was performed in 1980, however, had a small population (29 patients), and a short mean follow-up duration (4 months). As mentioned previously, Patchell, et al.,⁴⁰ recently performed a prospective randomized trial in 101 patients with spinal cord compression caused by metastasis. These authors showed that patients treated with surgery followed by radiotherapy maintained continence and had functional Frankel and American Spinal Injury Association Scale scores significantly longer than patients who were treated with radiotherapy alone. Also, a significantly larger number of non-ambulatory patients in the surgery group (56%) than in the radiotherapy group (19%) regained the ability to walk.

Four Class II studies have been published.^{51,55,59,62} In two of these studies the authors have proposed treatment algorithms.^{51,59} Wai and colleagues⁶² used the Edmonton Symptom Assessment Scale both pre- and postoperatively in 25 consecutive patients who underwent surgery for spinal metastases. This study, as well as several Class III studies,^{13,14,19,24,26,48,63,64} indicated an improved quality of life in patients who had undergone surgery for spinal metastases.

Several studies showed that the majority of patients who underwent surgical decompression for spinal me-

TABLE 1
Literature review of studies of surgical management of vertebral column metastatic disease

<i>Class I</i>			
<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Young, et al., 1980	Randomized prospective study of 29 patients who underwent laminectomy plus radiation (16 patients) versus radiation alone (13 patients)	Mean follow-up was 4 months. Pre-op ambulation was 50% in surgery group, and 100% in radiation group. Postoperative (4 month) ambulation was 58% in surgery group and 60% in radiation group.	This study showed no significant difference in the outcome of those who underwent surgery plus radiation compared to those who underwent radiation alone.
<i>Class II</i>			
<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Siegel, 1985	Prospective review of 86 patients with spinal cord compression treated surgically: 61 via corpectomy and 25 via laminectomy. An algorithm for surgical indications is proposed.	Improvement in ambulation, bowel, and bladder dysfunction were seen in the corpectomy group and, to a lesser degree, the laminectomy group.	Role of surgical decompression as the primary treatment for ventrally located tumors should be strongly considered, while the role of laminectomy in posterior compartment tumors is less certain.
Sundaresan, et al., 1991	Prospective study of 54 patients comparing <i>de novo</i> surgical spinal metastasis patients to historical controls, 24 ambulatory and 30 non-ambulatory	46% of patients survived 2 years, 37 patients also received radiation. 22% of survivors were ambulatory. 90% had pain relief.	Major benefit of surgery preserving ambulation that persists in long-term survival.
Tomita, et al., 2001	Two parts: Retrospective review of 67 patients and scored based on prognostic factors. Treatment strategy was devised and 61 patients were treated prospectively with this paradigm.	Mean survival was 38.2 months for 28 patients treated with wide or marginal resection, 21.5 months for 13 patients with intralesional excision, 10.1 months for 11 patients with palliative surgery, and 5.3 months for those with terminal care.	Treatment algorithm proposed based on prognostic factors including grade of malignancy, visceral metastases, and bone metastases.
Wai, et al., 2003	Prospective quality of life assessment of 25 patients using Edmonton Symptom Assessment Scale.	Surgery showed significant improvement in pain, tiredness, nausea, anxiety, drowsiness, appetite, and well-being.	Surgery improved quality of life in patients with spinal metastasis.
<i>Class III</i>			
<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Akeyson & McCutcheon, 1996	Retrospective review of 25 patients who underwent posterior vertebrectomy for metastatic disease of the thoracolumbar spine.	At time of review, 22 of 25 patients had died. Mean survival after surgery was 29.5 +/- 8.2 weeks. Majority had improvement in pain. 55% improved neurologically. Functional status was improved or unchanged in all patients. 76% had no improvement in functional status.	Posterior vertebrectomy is feasible for radical resection of vertebral body metastases when combined with reconstruction and stabilization for patients in whom thoracotomy is contraindicated. However, complication rate is high.

TABLE 1, continued
Literature review of studies of surgical management of vertebral column metastatic disease

Class III, continued

Reference	Description	Results	Conclusion
Arbit & Galicich, 1995	Retrospective review of 10 patients who underwent anterior vertebral body resection using modified Harrington distraction system.	Five patients underwent single level resection, 3 had a 2 level, and 1 a 3 level. Most had pain relief, but there was little improvement in ambulatory function.	Anterior fixation is a feasible and safe technique in this patient population to ensure stability. Pain is improved, but improvement in neurologic function is limited.
Bach, et al., 1990	Retrospective population cohort review over a 6 year period of 398 patients with spinal cord compression secondary to cancer.	31% had laminectomy, 26% had laminectomy followed by radiotherapy, and 43% had radiotherapy alone. 79% of those who were ambulatory remained ambulatory, while only 18% of the non-ambulatory patients regained ambulation. Patients who had surgery followed by radiotherapy had a better response.	Early diagnosis and aggressive treatment may preserve gait function in 80% of ambulatory patients developing spinal cord compression.
Bilsky, et al., 2001	Retrospective outcome analysis of 59 patients who had surgery for metastatic sarcoma of spine.	95% of patients maintained or regained ambulation. Median survival was 18 months, median interval between 1 st and 2 nd operations was 13 months.	Surgery is useful in maintaining or improving neurological and functional outcomes.
Bruckman & Bloomer, 1978	Retrospective review of indications for laminectomy for decompression prior to widespread use of anterior approaches in 312 patients.	Best prognostic indicator for recovery of function was pre-treatment status. Of patients who were paraplegic preoperatively, 35% were ambulatory after surgery. Only 7% of those who were paraplegic became ambulatory.	Early surgical intervention is indicated in patients who have rapidly progressive or severe neurologic symptoms.
Caspar, et al., 1999	Retrospective case study of 30 patients with cervical spinal vertebral neoplasms who underwent anterior cervical decompression and plate stabilization within a 7 year period.	All but one patient benefited from a significantly improved quality of life with decreased pain and/or improved neurological status. Patients achieved long-term stability, with only one patient requiring a repeat posterior stabilization procedure. There was no difference in survival between patients with metastatic neoplasms and those with lymphomatous and multiple myeloma neoplasms.	Favorable clinical outcome of both neurological symptoms and pain can be achieved with anterior cervical plate stabilization after surgery for neoplasms of the cervical vertebrae. Long-term mechanical stability is achieved even when radiation is delivered to the site of the bone graft.
Chataigner & Onimus, 2000	Retrospective review of 107 patients who were operated on for spinal metastases.	Preoperative vertebral pain in all patients, 43 had radicular complaints, 93 patients were dead at time of review.	Surgery in patients without neurological deficit increases functional status, but does not improve survival.
DeWald, et al., 1985	Retrospective review of 17 patients with metastatic malignancies who underwent anterior corpectomy, and in some cases posterior fusion.	5 cervical, 11 thoracolumbar tumors. 11 of 17 patients had improvement in pain, 5 of 11 paralyzed patients had significant neural recovery, and all maintained spinal stability. 3 died within 1 month of surgery.	Goals of surgery should be to decrease pain, to preserve or to improve neurologic function, and to mobilize the patient without external orthosis.
Dunn, et al., 1980	15 year retrospective review of 104 consecutive patients with epidural metastatic neoplasms treated with decompressive laminectomy and spinal irradiation.	33 % benefited from surgery, 23% became worse, 22% of non-ambulatory patients regained ambulatory function, but 22% of ambulatory patients were unable to walk after surgery. Tumor histology and preoperative neurological status important prognostic factors.	Indications for surgery include need for histological diagnosis, neurological deterioration, during radiotherapy, or recurrent symptoms.
Durr, et al., 2002	Retrospective review of 27 consecutive patients with solitary or multiple myeloma treated surgically.	1 year after surgery, 24 patients survived and had improved from presurgical condition based on Frankel, Karnofsky, and Kaplan Meier scoring systems.	Surgery for multiple myeloma is effective in improving neurologic function and quality of life.
Fourney, et al., 2001	Retrospective review of 26 patients who had combined anterior-posterior approach for spinal tumors.	15 patients had primary malignant spine tumors, 11 patients had mets. 96% had improvement in pain at one month.	Combined anterior-posterior approach for reconstruction is safe and feasible.

TABLE 1, *continued**Literature review of studies of surgical management of vertebral column metastatic disease**Class III, continued*

<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Ghogawala, et al., 2001	Retrospective review of 85 patients with symptomatic spinal cord compression treated with radiation only, radiation followed by surgery, or surgery followed by radiation.	Radiation prior to surgery increased wound infection from 12 to 32%. Patients who had surgery prior to radiation had superior Frankel score, and 75% remained ambulatory.	Radiation prior to surgery increases wound complication rate and may adversely affect surgical outcome.
Gokaslan, et al., 1998	Retrospective review of outcomes of 72 patients with metastatic spinal tumors who were treated with trans thoracic vertebrectomy, decompression, reconstruction with methylmethacrylate, and anterior fixation.	Posterior supplementation was required in 7 patients. 92% had improvement in pain, 67% had improvement of neurological dysfunction. 10 of 13 patients who were non-ambulatory preoperatively could walk after surgery.	Trans thoracic vertebrectomy and spinal stabilization can improve the quality of life of cancer patients with spinal mets by preserving or restoring ambulation and by controlling intractable pain.
Hall & Mackay 1973	Retrospective review of 129 patients undergoing laminectomy over 10 year period for compression of spinal cord or cauda equina.	35% of patients who had incomplete paraplegia and had immediate laminectomy regained ambulation.	Early diagnosis is key to improving postoperative outcome after posterior decompression for patients with incomplete paralysis.
Hammerberg, 1992	Retrospective review of 56 consecutive patients who underwent surgical intervention for metastatic spine disease.	91% of patients had significant pain improvement, 74% had neurologic improvement.	Goal of surgical treatment of metastatic spine disease is to improve the quality of the remaining life, by the relief of pain and preservation or restoration of neurologic function.
Harrington, 1984	Retrospective analysis of 52 patients with spinal instability secondary to metastatic pathological fractures who underwent anterior decompression and stabilization by replacement with MMA.	40 patients had major neurological impairment preoperatively, and 21 had complete recovery postoperative, 13 improved significantly, and 6 remained unchanged or worsened. Three cases had failure of fixation.	While this technique should not be applied to all patients with spinal mets, anterior decompression of lesions compressing the spinal cord is usually highly effective in reversing even high grade deficits, and provides immediate pain relief.
Hosono, et al., 1995	Retrospective review of clinical outcome of 84 patients who underwent vertebral body replacement via anterior approach with ceramic prosthesis.	94% had pain relief, 81% had improvement in motor function, and 64% recovered ambulation.	Vertebral body replacement can be useful after tumor resection for managing pain or neurologic deficits.
Jackson, et al., 2001	Retrospective review of 79 patients treated surgically for renal cell carcinoma metastatic to the spine.	79 patients underwent 107 spinal operations. Internal fixation performed in all patients. Median survival was 12.3 months, with significant pain reduction in 89%, neurological improvement in 65%.	In patients with renal cell carcinoma metastatic to the spine, resection and stabilization can provide pain relief and neurological preservation or improvement.
Lee, et al., 1986	Retrospective review of 20 patients who were treated surgically using anterior approach for anterior lesions, posterior approach for posterior lesions, and combined approach for extensive lesions.	Author's grading scale rated results as excellent in 7 patients, good in 6 patients, and fair in 7 patients.	In selected patients, these guidelines result in satisfactory outcomes.
Manabe, et al., 1989	Retrospective review of 25 patients with vertebral body involvement who underwent corpectomy and reconstruction.	75% had excellent result from surgery. All patients had pain relief. Incontinence resolved in 5 of 8 patients. Average survival was 8 months. There was no correlation between type of tumor and surgical result, or between surgical approach and neurologic prognosis.	Goal of surgical treatment of metastatic spinal tumors should be to maintain neurologic function without pain for duration of life expectancy.
McDonnell, et al., 1996	Retrospective review of 19 patients undergoing anterior procedures of the spine.	21% had major complications, and 16% had minor complications. Higher rate of major complications was found with combined anterior and posterior procedures rather than with staged anterior and posterior procedures.	Rate of major complications after anterior decompression and fusion is high, with most (37%) of complications related to pulmonary issues.

TABLE 1, continued

Class III, continued Literature review of studies of surgical management of vertebral column metastatic disease

<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Moore & Uttley, 1989	Prospective series of 26 consecutive patients who underwent single stage anterior decompression and stabilization for malignant spinal disease.	62% of those who were not ambulatory become ambulatory after surgery. 71% of those with intractable pain were pain free after surgery. Postoperative mortality rate was 30%.	Anterior stabilization is recommended in selected patients for management of cord compression caused by collapse of the vertebral body.
Nicholls & Jarecky, 1985	Retrospective review of 38 patients who underwent laminectomy over a 20-year period.	30% of patients received some benefit from surgery. Overall survival was 14 weeks. If neurologic function improved after surgery, survival was 18 weeks compared to 8 weeks if symptoms worsened.	Overall outcome for decompressive laminectomy for epidural metastases is poor, and patients' longevity should be considered before recommending decompressive laminectomy.
Onimus, 1986	Retrospective review of 57 patients undergoing 60 operations for vertebral metastases. 36 patients underwent anterior approach with corpectomy and stabilization, 24 patients underwent laminectomy and/or instrumentation.	93% of patients had improvement of pain postoperatively. 65% of non-ambulatory patients were ambulatory after surgery. Six month survival was 79%.	Surgery is beneficial and should be preferred to radiation alone when there is medullary compression by bony metastasis and the presence of pain or potential spinal instability.
Perrin & McBroom, 1987	Retrospective comparison of 200 consecutive patients treated with posterolateral decompression with 21 patients treated with anterior decompression and stabilization.	Pain relief was 80% in the posterolateral group, 90% in the anterior group. Ambulation in the posterolateral group was 65% postoperatively vs. 37% preoperatively. Ambulation in the anterior group was 76% postoperatively vs. 38% preoperatively.	Successful surgical management requires both decompression of spinal cord and nerve roots as well as stabilization of the spine. Surgical approach is determined by tumor location, spinal level, fixation factors, and patient debility. No single approach is always applicable.
Preciado, et al., 2002	Retrospective review of 11 patients with head & neck cancer metastatic to spine.	Patients offered surgery if life expectancy > 6 months.	Surgery is viable option for patients with cord compression, unstable spine, and/or life expectancy > 6 months.
Schoegg, et al., 2002	Retrospective outcome measurement of 84 patients who had surgery for malignant spinal mets.	Patients who were paraplegic did not show functional improvement.	Patients undergoing surgery had improvement in quality of life, except for those patients who were paraplegic prior to surgery.
Siegal, 1989	Retrospective review of indications for surgical intervention. Determinants of functional prognosis include tumor biology, pretreatment neurological status, and tumor location within the spinal canal and the therapy employed.	First line radiotherapy is indicated in highly or moderately radiosensitive tumors. The location of the compressing tumor will dictate the approach.	Surgery should be reserved for those with unknown diagnosis, previous radiation exposure, radioresistant tumors, neurologic deterioration during irradiation, and the presence of instability of bone compression of neural structures. Modern instrumentation techniques allow immediate painless ambulation in a large percentage of patients.
Siegal & Tiqva, 1985	Retrospective review of 40 patients with epidural compression. Indications for surgery included relapse after radiotherapy, need for diagnosis, radioresistant tumor, neural deterioration during radiotherapy, and pathological fracture-dislocation. Treatment algorithm is presented.	70% were in thoracic spine. 31% of non-ambulatory patients gained the ability to walk after surgery. Bowel and bladder incontinence resolved in 46% of patients. Pain relief was achieved in 61% of the operations.	In view of the large number of patients who regained the ability to walk after anterior decompression, the role of surgical intervention as a primary treatment for epidural compression by tumor should be considered. Pain relief and resolution of incontinence was also achieved in a significant number of patients.
Sorensen, et al., 1990	Retrospective review of all patients in eastern Denmark with metastatic compression of spinal cord or cauda equina between 1979 and 1985 (345 patients).	Outcome primarily dependent on patients' condition at time of diagnosis. 79% of those who were ambulatory remained so, while only 21% of those who were non-ambulatory regained ability to walk. There was a longer survival in those treated with laminectomy and radiotherapy.	Laminectomy followed by radiotherapy may reflect a lower stage of disease and thus had a better potential for regaining motor function. Results call for prospective randomized studies.

TABLE 1, continued
Literature review of studies of surgical management of vertebral column metastatic disease

Class III, continued

<i>Reference</i>	<i>Description</i>	<i>Results</i>	<i>Conclusion</i>
Sucher, et al., 1994	Retrospective review of 59 patients from 1981 to 1990 who underwent anterior spinal decompression and, in most cases, stabilization with MMA and/or instrumentation.	75% were improved neurologically, 1/3 showing complete recovery from spinal cord compression. Results were better in those younger female patients suffering from metastatic breast cancer. Genitourinary system tumors had a relatively poorer prognosis.	Anterior spinal decompression and stabilization for metastatic disease is a treatment option.
Sundaresan, et al., 2002	Retrospective database of 80 patients with solitary spinal mets with epidural extension from solid tumors.	Surgical morbidity was significantly higher in patients with prior irradiation.	Surgical excision should be performed prior to irradiation.
Tang, et al., 1983	Retrospective review of 51 patients with metastatic spinal cord compression.	Patients who had laminectomy followed by radiotherapy had better results than those who had radiotherapy alone.	In patients who are ambulatory, radiotherapy alone is an option. Paraparetic patients with radiosensitive tumors do well with radiotherapy alone, but patients with epithelial tumors merit laminectomy plus radiotherapy. Paraplegic patients rarely benefit from either modality.
Turner, et al., 1988	Retrospective review of 41 patients with malignant extradural tumors of the spine treated with anterior decompression.	37 patients had anterior operation alone, 4 had combined anterior and posterior decompression. 56% achieved major neurological recovery. 4 patients remained unchanged. 11 patients had minor improvement. No patient with complete paraplegia regained useful neurological recovery. Back pain was improved in 73% of patients.	Anterior decompression is an option in the treatment of malignant extradural tumors of the spine.
Walsh, et al., 1997	Retrospective review of 61 patients from 1994 to 1996 who underwent anterior resections of thoracic spine tumors.	90% of patients had significant improvement in pain after surgery. 12 of 16 patients who initially presented in wheelchairs regained ambulatory function. 1-year cumulative survival was 60%.	An aggressive surgical approach in cancer patients with locally advanced or metastatic disease in the thoracic spine was associated with acceptable morbidity and mortality. There was significant improvement in quality of life by controlling intractable pain in 90% and recovery of ambulatory function in 75% of patients.
Weigel, et al., 1999	Retrospective review of postoperative outcome and quality of life in 86 surgical interventions in 76 consecutive patients with symptomatic spinal metastases.	Postoperative mean survival was 13.1 months, and mean time at home after surgery was 11.1 months. Neurological improvement in Frankel Score was seen in 58% of patients and 93% of patients were able to walk postoperatively. Pain relief was noted in 89%. 19% of surgical interventions were associated with complications and local tumor recurrence developed in 22%.	Anterior decompression is of benefit in most metastatic lesions in terms of satisfactory postoperative outcome and quality of life.
Wise, et al., 1999	Retrospective review of 80 patients who underwent surgical treatment for metastatic spinal disease.	65 patients showed no change in Frankel score, 19 improved one Frankel grade, and 1 deteriorated one Frankel grade. 1 patient had paraplegia. 35 complications occurred in 20 patients, and 10 patients had multiple complications accounting for 23 of the 35 postoperative problems.	Most complications occurred in a small number of patients, indicating that careful patient selection should be based on expected length of survival, use of radiation therapy, presence of neurological deficit, and impending spinal instability or collapse caused by bone destruction.
Yen, et al., 2002	Retrospective review of 27 patients with spinal metastases who had Wellesley Wedge applied.	33% suffered medical complications, 22% had improved Frankel Score postoperatively. 92% maintained spinal stability throughout lifespan.	Wellesley Wedge provides durable long-term spinal stability in treating properly selected patients with spinal mets.

TABLE 1, continued
Literature review of studies of surgical management of vertebral column metastatic disease

Class III, continued

Reference	Description	Results	Conclusion
Cahill & Kumar, 1999	Retrospective review of 9 of 43 patients with spinal metastatic disease who underwent palliative subtotal vertebrectomy with anterior and posterior reconstruction via a simple posterior approach.	8 of 9 patients died of progression of underlying disease. All patients remained pain free until days before they died. All patients except for one (who presented with paraplegia) remained ambulatory.	Use of near-total vertebrectomy followed by anterior and posterior reconstruction using a single midline posterior approach is a treatment option in patients with limited life expectancy.
Tomita, et al., 1994	Technique paper on total en bloc spondylectomy, done on 24 patients.	14 of 18 patients with neurological deficits improved, and 23 cases experienced pain relief. 12 patients survived after a median follow-up period of 14.1 months.	Total en bloc spondylectomy may have significant clinical value in treatment of spinal metastasis.
Weller & Rossitch, 1995	Retrospective analysis of 8 patients with spinal metastases and limited life expectancy who underwent limited unilateral transpedicular decompression.	All patients were improved within first postoperative week, and all were ambulatory and continent postoperatively. All 5 with motor weakness had improved strength.	Limited unilateral transpedicular decompression without stabilization is an effective and safe treatment for symptomatic spinal metastatic disease.

MMA = methyl methacrylate.

tastasis maintained ambulation.^{6,8,17,24,25,27,29,38,41,51–55,63–65} In contrast, Arbit and Galicich⁵ performed a retrospective review of 10 patients who underwent anterior vertebral body resection and found little improvement in ambulatory function, but noted improvement in pain. In four studies, patients who presented with paraplegia or severe neurological dysfunction showed little or no improvement after surgery.^{10,48,58,61} DeWald, et al.,¹⁷ found improvement in five of 11 patients presenting with paraplegia. In two studies,^{34,52} bladder continence improved in patients who underwent surgery.

In terms of survival, Sorensen, et al.,⁵³ showed that patients who underwent laminectomy followed by radiotherapy attained a longer survival duration; however, this may have reflected a milder stage of disease in these patients, which would improve the potential for survival. Chataigner and Onimus³ and Akeyson and McCutcheon¹⁴ showed that although pain and neurological function improved in patients who underwent surgery, survival did not change. At the time of this retrospective review, 93 of 107 patients were dead. Radiation treatment alone was advocated as a first-line therapy for patients with highly or moderately radiosensitive tumors⁵⁰ and in those who were ambulatory;⁵⁸ although Tang, et al., showed that patients who underwent laminectomy followed by radiotherapy attained better results than those who underwent radiotherapy alone.

Outcome improved for patients who underwent surgery prior to radiation.^{6, 22,38,57} Preoperative radiation increased the risk of wound complications and infection in two studies.^{22,57} Ghogawala, et al., found that the major wound complication rate was 32% in patients who underwent surgery after radiation, compared with 12% in patients in whom de novo surgery was performed. Sundaresan, et al., also found a 25% incidence of wound breakdown (10 of 40) in patients with prior radiation therapy compared with

one wound infection in 40 in patients who underwent de novo surgery. One Class III study showed that the risk of major complications was significant,⁶⁴ and McDonnell, et al.,³⁵ showed a major complication rate of 21% in patients who underwent anterior decompression and fusion; the majority of complications were related to pulmonary issues.

Several different approaches were used to ensure long-term stability for fusion, including the Wellesley wedge,⁴⁹ anterior cervical plating,¹³ and anterior corpectomy.¹⁷ Surgical decompression improved pain^{3,5,17,20,24,26,27,29,30,34,38,41,52,61,63} and the quality of life^{13,14,24,63,64} in several studies. Nevertheless, three studies indicated that the patients' longevity should be taken into account when determining the indications for surgery.^{37,43,66}

DISCUSSION

Directions for Future Research

Prospective, randomized clinical trials are needed to compare the outcome in patients treated with surgical intervention with the outcome in patients receiving radiotherapy as a first-line treatment. Additional large-cohort studies would add Class II evidence that would be valuable in assessing the role of surgical intervention. Other areas of interest include surgical methods, extent of tumor resection, and the role of multimodality therapies.

Treatment Recommendations

Standards. There is insufficient evidence to recommend a treatment standard.

Guidelines. Surgical decompression and stabilization in the face of spinal instability is recommended for patients who experience progressive neurological deficits without

complete paraplegia, bowel or bladder dysfunction, or significant pain. The goal of surgical intervention should be to improve pain and/or the quality of life and may have no effect on the survival rate. We recommend that surgical decompression and fusion be considered with caution for patients who present with complete paraplegia, unless these procedures are required for diagnostic purposes.

Options. Radiotherapy should be considered as a treatment option for patients who present with complete paraplegia or paralysis related to spinal metastatic disease. Radiotherapy may also be considered as a treatment option for patients who are ambulatory, with minimal neurological deficit or pain, especially in patients who harbor a known, radiosensitive tumor. Patients who experience progressive neurological deficits despite receiving radiotherapy should be considered candidates for urgent surgical decompression and/or stabilization.

CONCLUSIONS

Surgical intervention for metastatic spinal disease is beneficial in that it alleviates pain caused by metastases and improves the patient's quality of life. Nonetheless, there has been insufficient evidence to show that surgical intervention will improve survival duration. Surgical decompression and fusion have been shown by a number of methods and approaches to produce spinal stability and maintain it for the remainder of the patient's life. Patients presenting with significant neurological deficits may experience marked improvement after surgical decompression and fusion, assuming that the individual does not present with complete paraplegia. There has been insufficient evidence to recommend surgical intervention routinely in patients who present with complete paraplegia. Radiotherapy without surgical intervention should be reserved for the following categories of patients: 1) those who have known, radiosensitive tumors; 2) those who have little or no pain or neurological deficit; or 3) as a palliative therapy in patients who present with paraplegia.

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