Check for updates

review article

Assessment and Management of Patients With Metastatic Spinal Cord Compression: A Multidisciplinary Review

Andrew J. Lawton, MD[1,2]; Kathleen A. Lee[1,2]; Andrea L. Cheville[3]; Marco L. Ferrone[1,2]; Dirk Rades[4]; Tracy A. Balboni[1,2]; and Janet L. Abrahm[1,2]

abstract

PURPOSE Metastatic spinal cord compression (MSCC) can be a catastrophic manifestation of advanced cancer that causes immobilizing pain and significant neurologic impairment. Oncologists can protect their patients by having a high index of suspicion for MSCC when patients present with new or worsening back pain before motor, sensory, bowel, or bladder deficits develop. We provide an updated, evidence-based narrative review of the presentation, diagnosis, and treatment of MSCC.

METHODS This narrative review was conducted by searching MEDLINE and Cochrane Database of Systematic Reviews for relevant literature on the presentation, diagnosis, and treatment of patients with MSCC. The article addresses the key elements of MSCC management germane to the medical oncologist, with special attention given to pain and symptom management, decision making with regard to surgery and radiation therapy, the importance of rehabilitative care, and the value of a multidisciplinary approach.

RESULTS Magnetic resonance imaging of the entire spine is recommended for the diagnosis of MSCC. Treatment includes glucocorticoid therapy, pain management, radiation therapy with or without surgery, and specialized rehabilitation. When formulating a treatment plan, clinicians should consider the patient's care goals and psychosocial needs.

CONCLUSION Prompt diagnosis and treatment of MSCC can reduce pain and prevent irreversible functional loss. Regular collaboration among multidisciplinary providers may streamline care and enhance achievement of treatment goals.

J Clin Oncol 37:61-71. © 2018 by American Society of Clinical Oncology

ASSOCIATED CONTENT

Appendix

Author affiliations and support information (if applicable) appear at the end of this article.

Accepted on September 5, 2018 and published at jco.org on November 5, 2018: DOI https://doi.org/10.1200/JCO.2018.78.1211

The views expressed in this article are the authors' own and not an official position of the Dana-Farber Cancer Institute, Brigham and Women's Hospital, Mayo Clinic, or University Hospital Lübeck.

INTRODUCTION

Metastatic spinal cord compression (MSCC) is a distressing manifestation of cancer associated with pain, progressive neurologic decline, and a short prognosis. Given the potential for irreversible loss of motor function and paralysis, MSCC is an oncologic emergency that requires prompt diagnosis and management.[1]

MSCC develops in approximately 2.5% to 5% of patients dying as a result of cancer; the incidence varies significantly by primary tumor type.[2-4] Among patients hospitalized for MSCC, the majority (61%) have primary lung, prostate, or breast cancer,[2] and MSCC is the first manifestation of systemic cancer in 20% to 34%.[5,6] Multiple myeloma, which accounts for 11.1% of this patient population,[3] and lymphoma often are widespread at diagnosis, and spinal cord compression in these patients is described as SCC rather than MSCC. Whether patients with SCC as a result of myeloma or lymphoma should be included in MSCC studies is controversial.[7,8]

Oncologists have a high index of suspicion for MSCC in patients with cancer who present with back pain and aim to diagnose the condition before neurologic impairment develops or worsens.[1,5,9,10] Prompt assessment and management are crucial to prevent additional motor loss, treat pain, and help patients to adjust to changes in level of function and independence.[1,9,11] The high morbidity and mortality associated with MSCC highlight the importance of concomitant palliative care, particularly for patients who do not regain ambulatory function.[12]

In this article, we provide an updated evidence-based review on the presentation, diagnosis, and treatment of MSCC. We also highlight the value of using a multidisciplinary team approach, including medical and radiation oncologists, spine surgeons, palliative care clinicians, physiatrists, and psychosocial clinicians.

METHODS

We conducted this narrative review by searching MEDLINE (through PubMed) and the Cochrane Database

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

of Systematic Reviews from inception to July 2018. The search strategy, including Medical Subject Heading terms and free-text keywords, are listed in Appendix Table A1 (online only). Two authors (A.J.L., K.A.L.) reviewed the subsequent database abstracts and reference lists of relevant screened articles for inclusion in the review. We included studies and review articles that reported on the presentation, diagnosis, and treatment of MSCC and excluded studies not reported in English.

RESULTS

Pathogenesis and Clinical Presentation

MSCC in solid tumors typically results from the hematogenous spread of malignant cells to the vertebral body; the vertebral mass enlarges and compresses the adjacent epidural venous plexus, spinal artery, thecal sac, and spinal cord and produces pain and neurologic deficits.[13] Hematologic malignancies emanate from bone marrow. Multiple myeloma typically presents with soft tissue extension from lytic bone lesions as a result of activation of osteoclasts and inhibition of osteoblasts. Lymphoma often presents with sclerotic bone disease with soft tissue growth into the epidural space. When solid or hematologic malignancies cause weakening of the bone, vertebral compression fractures may result, with bony fragments compromising the spinal cord.[14] The thoracic spine is affected most commonly in MSCC followed by the lumbosacral and cervical spine.[2,9,15]

Key presenting features of MSCC include back pain, motor weakness, sensory deficits, and bowel or bladder dysfunction. Signs and symptoms vary according to pathophysiology (upper or lower motor lesion) and spinal location. Back pain is the most common presenting symptom, reported by 80% to 95% of patients.[1,4,9,10,15,16] The pain of early MSCC is typically constant, aching, and worse at night or early morning. It may be exacerbated by coughing, sneezing, Valsalva maneuvers, and lying flat.[9,17] The latter situation typically represents instability in the thoracic spine or the thoracolumbar junction because of pathologic movement of an unstable kyphosis. Cervical MSCC may cause midscapular pain, thoracic compression may cause thoracic pain or band-like tightness across the chest or upper abdomen, and lumbosacral compression may cause lumbosacral or hip pain.[18,19] Movement exacerbates the pain of vertebral fracture or instability (ie, mechanical or functional pain). Radicular burning pain or referred pain may accompany more advanced MSCC.

Motor deficits are found in 35% to 75% of patients with spinal metastases at diagnosis.[19-21] A minority of patients are nonambulatory, and others describe subtle heaviness or clumsiness in the extremities.[17] Upper motor neuron deficits are typically symmetric, whereas lower motor neuron deficits tend to be asymmetric. The distal extremity often is involved first with lower motor neuron lesions.[22] For example, cervical compression may cause impaired dexterity and paresthesia of only one hand, which may be misdiagnosed as carpal tunnel syndrome.

Patients less often report sensory changes,[22] and the level of sensory deficit on examination may correlate poorly with the level of the spine lesion.[1,23] Although rarely the presenting complaint, patients with MSCC also may have bowel or bladder dysfunction.[1,4,9,24] Such autonomic deficits tend to occur later, along with worsening motor weakness,[17,25] and are associated with a poorer functional outcome after treatment.[9,17,26]

Specific Diagnostic Considerations

New-onset back pain and/or new neurologic deficits in a patient with cancer should trigger urgent spinal imaging. Magnetic resonance imaging (MRI) is the gold standard for diagnosing MSCC, with a sensitivity of 93% and specificity of 97%.[27] MRI of the entire spine is recommended[28] because 20% to 35% of patients have multiple, noncontiguous levels of compression and because pain and neurologic deficits may not correlate with the level of spinal lesions on imaging.[16,23,29] Defining the extent of spinal disease helps with planning treatment with surgery and/or radiation therapy (RT).[30]

Computed tomography myelography[31,32] is recommended only when MRI is contraindicated. No other imaging modalities are adequate. Plain films are insensitive[4]; x-ray computed tomography is less detailed than MRI for assessing the spinal cord and soft tissue structures[33]; positron-emission tomography has poorer anatomic resolution than MRI, and a negative study does not rule out MSCC.[34,35]

Initial Management

Glucocorticoids. Glucocorticoid therapy provides analgesia and preserves neurologic function.[17,18,36] Dexamethasone is standard; it downregulates the production of vascular endothelial growth factor and prostaglandin E2, which causes a decrease in spinal cord edema and delays the onset of neurologic decline.[13,18] Optimal dosing in patients with MSCC is unknown. In 57 patients who received RT for MSCC, those administered high-dose dexamethasone (96 mg intravenous bolus, then 96 mg intravenously for 3 days, then tapered over 10 days) had higher ambulation rates at 3 and 6 months than those without corticosteroid therapy.[24] Eleven percent of patients developed adverse effects from the dexamethasone (hypomania, psychosis, or perforated gastric ulcer). In a pilot study of high-dose dexamethasone (96 mg for 3 days, then tapered) versus moderate-dose dexamethasone (16 mg for 3 days, then tapered), however, no significant difference in functional outcomes at 1 month was found.[37] The small sample size limited the ability to draw firm conclusions. A 2015 Cochrane Review concluded that high-dose dexamethasone (96- to 100-mg bolus dosing) carries a high risk of serious adverse effects in patients with MSCC (including

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

perforated gastric ulcer, psychoses, and death as a result of infection) and that whether high dosing provides an additional benefit over moderate dosing (10- to 16-mg bolus dosing) is unclear.[38] Our practice and that of other experts[39-41] is to use an initial bolus of dexamethasone 10 mg intravenously followed by 4 to 6 mg intravenously every 6 hours. The corticosteroid is tapered over 2 weeks, as tolerated, usually after completion of RT.[10,11]

Pain and symptom management. Most patients with MSCC require opioids for pain relief[33] that often are combined with adjuvant analgesics. Table 1 lists initial analgesic doses for opioid-naïve patients. Opioid-tolerant patients may require much higher doses. Patients with moderate or severe pain often benefit from continuous intravenous opioid administration initially, with nurse-administered boluses or patient-controlled analgesia for breakthrough pain.[18]

TABLE 1. Pain Management in Opioid-Naïve Patients With Metastatic Spinal Cord Compression

Drug	Initial Dose
Opioids	
Morphine*	
Immediate release	7.5-15 mg orally every 3 hours as needed or 2-4 mg intravenously every 2 hours as needed
Sustained release†	15 mg orally every 8-12 hours
Oxycodone*	
Immediate release	5-10 mg orally every 3 hours as needed
Sustained release†	10 mg orally every 8-12 hours
Hydromorphone*	
Immediate release	2-4 mg orally every 3 hours as needed or 0.4-0.8 mg intravenously every 2 hours as needed
Fentanyl*	
Sustained release†	12 μg/h transdermally every 72 hours
Neuropathic pain adjuvants	
Dexamethasone	10 mg orally or intravenous load, then 4-6 mg orally or intravenously every 6 hours
Gabapentin*	100 mg orally twice daily; 300 mg at bedtime
Pregabalin*	75 mg orally twice daily
Amitriptyline	10-25 mg orally at bedtime
Nortriptyline	10-25 mg orally at bedtime
Bone pain adjuvants	
Zoledronic acid‡	4 mg intravenously every 3-4 weeks
Pamidronate‡	90 mg intravenously every 3-4 weeks
Acetaminophen§	1,000 mg orally every 8 hours
Bowel regimen medications	
Senna	1-2 tablets twice daily
Polyethylene glycol	17 g one to two times daily
Bisacodyl suppository	Daily as needed

NOTE. From Abrahm[18] and Dworkin et al.[42]

*Decrease dose in renal (creatinine clearance < 50 mL/min) or hepatic impairment.

†Only use as an initial dose if the patient is already taking the equivalent of oral morphine.

‡Decrease dose or avoid in renal impairment (creatinine clearance < 50 mL/min).

§Limit to 2,000 mg/d in the setting of hepatic impairment.

Key neuropathic pain adjuvants include corticosteroids (eg, dexamethasone), anticonvulsants (eg, gabapentin, pregabalin), and tricyclic antidepressants. Dexamethasone treats both neuropathic pain and inflammatory pain from vertebral metastases. Gabapentin and pregabalin provide improved pain control over placebo in patients with spinal cord injuries,[42-44] although no studies have evaluated them in MSCC. Tricyclic antidepressants, such as amitriptyline and nortriptyline, also may provide pain relief, although they have not been shown in randomized trials to be more effective than placebo for neuropathic cancer pain.[42,45] Doses much lower than those needed for depression can be given at bedtime.[18,42] Providers should monitor for sedation, orthostasis, anticholinergic effects, and cardiac arrhythmias.

Although bisphosphonates, nonsteroidal anti-inflammatory drugs, and acetaminophen have not been studied in patients with MSCC, they also contribute to relief of pain from bone metastases.[46] A 2002 Cochrane Database Systematic Review of bisphosphonates estimated a number needed to treat of six patients to provide one patient with pain relief.[46] The pain improves over several weeks, with a maximum effect at 4 weeks.[46]

Patients with MSCC are at high risk for constipation as a result of opioid therapy, limited mobility, and autonomic injury. A prophylactic combination of a stimulant laxative and osmotic laxative, such as senna and polyethylene glycol, is effective for most patients (Table 1).[18] Docusate does not provide additional benefit beyond senna alone in managing opioid-induced constipation.[47] Patients with more severe constipation may require a suppository (eg, bisacodyl), enema, lactulose, or methylnaltrexone.

Surgical Intervention

Surgical intervention along with RT plays a central role in the management of patients with MSCC, particularly in cases of spinal instability and compression caused by bony fragments.[7] In addition to improvement of neurologic deficits, surgery has been reported to result in immediate and sustained pain relief and improved quality of life.[48-50] Interventions range from minimally invasive decompressions to highly sophisticated, individualized techniques that consider the location and extent of the MSCC. One such technique is surgical decompression with instrumented fusion (Fig 1). Vertebroplasty and kyphoplasty alone generally are not indicated for true MSCC with neurologic deficits, although these may be useful for painful vertebral compression fractures in patients without neurologic deficits.[51,52] Key factors in deciding whether to pursue surgery before RT include spinal stability, presence of neurologic deficits, and patient prognosis.

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

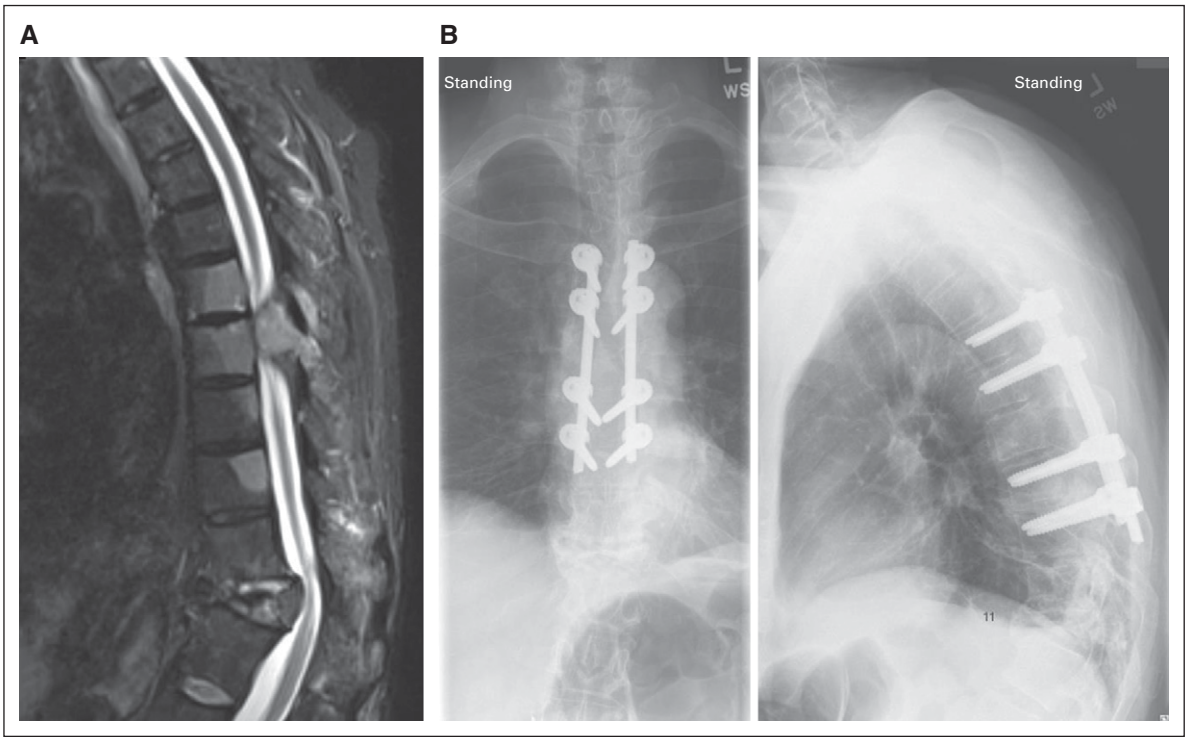

FIG 1. Surgical management of metastatic spinal cord compression with decompression and instrumented fusion. (A) Magnetic resonance sagittal image of the thoracic spine that demonstrates severe spinal cord compression at the T7 level. (B) Anteroposterior and lateral postoperative spine radiographs that show T7 decompression and T5 to T9 instrumented fusion.

Spinal stability. Spinal instability is an indication for surgical intervention. Patients with spinal instability often present with mechanical or functional pain (see Results, Pathogenesis and Clinical Presentation), which can herald an impending or pathologic fracture. The Spine Instability Neoplastic Score, with 95.7% sensitivity and 79.5% specificity for predicting spinal stability, can help to determine the need for surgical intervention for MSCC.[53] The score includes six characteristics of the spinal lesion (Table 2). Scores from 0 to 6 indicate a stable spine, 7 to 12 a potentially unstable spine, and 13 to 18 an unstable spine.

Presence of neurologic deficits. Neurologic deficits identified on examination and high-grade compression shown on MRI often are considered indications for surgery. The Epidural Spinal Cord Compression scale is a validated tool used to characterize the degree of compression on the basis of MRI findings[54] (Table 3). Grading ranges from 0, bone-only disease, to 3, compression with no CSF visible around the spinal cord.

Patient prognosis. Patients with MSCC and their providers need accurate prognoses to weigh potential surgical benefits of improved function and pain control against the risks of increased perioperative morbidity and mortality.[55] However, physicians often fail to estimate accurately the remaining lifespan of a patient with cancer.[56-60] Prognostication is all the more difficult in patients who undergo surgery for MSCC before RT; their survival is highly variable, and key predictors of survival are uncertain.[48,61,62]

To attempt to address this uncertainty, prognostic scoring tools that are based on clinical factors have been developed for patients with MSCC who undergo surgery. The Modified Bauer Score, originally proposed by Leithner et al,[63] identifies three prognostic groups (0 to 1, 2, or 3 to 4 points) on the basis of four factors (absence of visceral metastasis, presence of a solitary skeletal metastasis, a primary cancer that is not lung cancer, and a primary cancer that is breast or kidney cancer). One point is assigned for each positive answer (maximum, 4 points). According to Wibmer et al,[64] median survival times may be predicted as follows: 0 or 1 point to 4.8 months, 2 points to 18.2 months, and 3 or 4 points to 28.4 months. The New England Spinal Metastasis Score builds on the Modified Bauer Score by adding serum albumin and ambulatory status.[55] Other important instruments include validated tools developed by Paulino Pereira et al[65,66] and Bartels et al,[67,68] which indicate survival probabilities at specific time points. External validation that compares these tools for patients with MSCC has not yet been reported. An emerging role exists for molecular genetics and biomarkers as predictors of survival; however, these factors may not be available in an oncologic emergency such as MSCC.

 © 2018 by American Society of Clinical Oncology

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

TABLE 2. Spine Instability Neoplastic Score

Element	Score
Location	
Junctional (occiput-C2, C7-T2, T11-L1, L5-S1)	3
Mobile spine (C3-C6, L2-L4)	2
Semirigid spine (T3-T10)	1
Rigid spine (S2-S5)	0
Pain with recumbency and/or movement of spine	
Yes	3
Occasional, but not mechanical	1
No	0
Bone lesion	
Lytic	2
Mixed (lytic and blastic)	1
Blastic	0
Radiographic spinal alignment	
Subluxation or translation present	4
De novo deformity (kyphosis or scoliosis)	2
Normal alignment	0
Vertebral body collapse	
> 50%	3
< 50%	2
No collapse, with > 50% of body involved	1
None	0
Involvement of posterolateral spinal elements (facet, pedicle, or costovertebral joint fracture or replacement with tumor)	
Bilateral	3
Unilateral	1
None of the above	0
Total score	
Stable	0-6
Indeterminate	7-12
Unstable	13-18

NOTE. From Fisher et al.[53]

Management With Surgery Followed by RT Versus RT Alone

The randomized controlled trial of decompressive surgery and RT versus RT alone by Patchell et al[7] supported initial surgery in selected patients with solid tumors. Patients (n = 101) had a single site of true MSCC, no paraplegia for more than 48 hours, a prognosis of 3 months or more, no very radiosensitive histologies (ie, myeloma, lymphoma, and germ cell tumors were excluded), no prior RT to the site, and no brain metastases. Thirty-eight percent of participants had unstable spines. A greater proportion of participants randomly assigned to surgery before RT remained ambulatory compared with those randomly assigned to RT alone (84% *v* 57%; *P* = .001). Nonambulatory participants randomly assigned to surgery before RT were more likely to regain ambulatory function (62% *v* 19%; *P* = .01).

The Patchell et al[7] study was criticized for several limitations.[69-71] Because it took 10 years to accrue 101 patients, not all eligible patients seemed to be included. In addition, patients with instability were included, which likely resulted in a bias that favored surgery. The results in the RT alone group were also less favorable than in other studies, and the inclusion criteria were believed to be atypical for MSCC because the trial population represented only approximately 10% of patients with MSCC.

A subsequent matched-pair analysis of 324 patients who underwent surgery followed by RT versus RT alone by Rades et al[72] had different findings. Matching (1:2) was on 11 demographic and clinical factors, and vertebral fractures with bone fragments in the canal were excluded. In contrast to Patchell et al,[7] this study showed no difference between surgery and RT versus RT alone in the proportion of patients ambulatory after treatment (69% *v* 69%; *P* = .99) and among nonambulatory patients, in the proportion who regained ambulatory function (30% *v* 26%; *P* = .96). This study also was limited by its retrospective design, absence of patients with cervical metastases, and lack of consideration of the degree of spinal compression. It is difficult to compare the results of the Rades et al matched-pair study with those of the Patchell et al study because Rades et al included patients with very radiosensitive tumors, whereas Patchell et al excluded them. Of note, Rades et al[73] presented a subgroup analysis of their matched-pair study that included 201 patients with MSCC from an unfavorable tumor. Among patients treated with decompression plus stabilization, improvement of motor function was seen more often after the combined approach compared with RT alone (28% *v* 19%; *P* = .024). Additional studies are required to identify properly patients who would benefit from initial surgery followed by RT. When selecting the treatment, clinicians must consider that after RT, recalcification and stabilization of osteolytic bone may take

TABLE 3. The Epidural Spinal Cord Compression Scale

Grade	Description
0	Bone-only disease
1a	Epidural impingement, without deformation of the thecal sac
1b	Deformation of the thecal sac, without spinal cord abutment
1c	Deformation of the thecal sac, with spinal cord abutment, without cord compression
2	Spinal cord compression, with CSF visible around the cord
3	Spinal cord compression, with no CSF visible around the cord

NOTE. From Bilsky et al.[54]

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

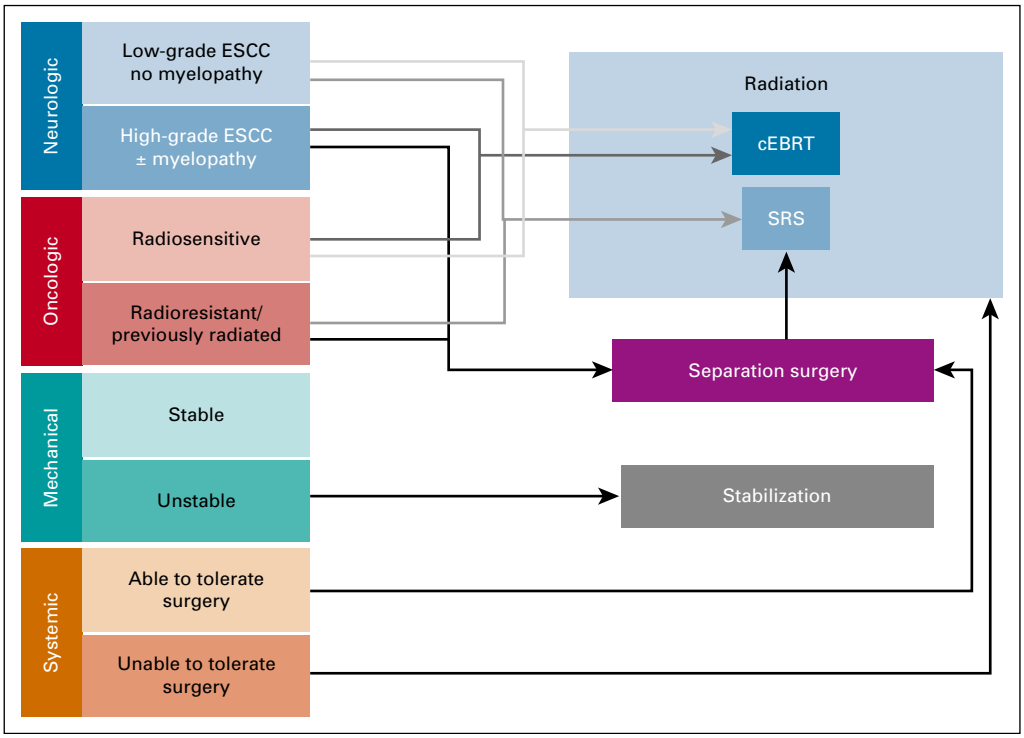

FIG 2. The neurologic, oncologic, mechanical stability and systemic disease framework. cEBRT, conventional external beam radiation therapy; ESCC, epidural spinal cord compression; SRS, stereotactic radiosurgery. Reprinted with permission from Barzilai et al.[74]

several months. Furthermore, salvage surgery for a recurrence of MSCC in the previously irradiated region likely will be associated with more pronounced wound dehiscence, bleeding, and infection.[7]

The neurologic, oncologic, mechanical, and systemic disease (NOMS) decision framework can guide clinicians in making treatment decisions about surgery and RT.[8,74] The NOMS framework takes into account the degree of spinal cord compression (using the Spine Oncology Study Group [SOSG] scoring system), presence of myelopathy, radiosensitivity of the tumor, stability of the spine, and the patient's ability to tolerate the proposed treatment (by accounting for other medical comorbidities, overall extent of disease, and prognosis). On the basis of these factors, recommendations include initial surgical intervention followed by RT, external beam radiation alone, and single-fraction or fractionated stereotactic body radiation therapy (SBRT; Fig 2). SBRT can be a reasonable option as primary treatment of low-grade MSCC without myelopathy, as postoperative management of MSCC from less radiosensitive tumors, and for re-irradiation after recurrent MSCC.[75] The NOMS framework also includes separation surgery (ie, resection of the epidural tumor and stabilization of the spinal column without significant vertebral body resection).[76] Separation surgery followed by high-dose SBRT (8 to 10 Gy × 3) or stereotactic radiosurgery (24 Gy × 1) has been reported to produce excellent local control of MSCC.[77] The 1-year local progression rates of 4% and 9% were much lower than the 19% observed in a previous prospective study of longer-course conventional RT.[77,78] However, the tolerance doses of the spinal cord and the vertebral bodies must be considered to avoid neurotoxicity and vertebral fractures, which occurred in 8% and 21% of patients in a phase I/II trial of 16 to 24 Gy × 1 of SBRT for vertebral metastases.[79]

Quality-of-life measurements also may guide choice of therapies.[48] The disease-specific SOSG Outcomes Questionnaire (SOSG-OQ) evaluates the quality of life of patients with MSCC.[80] With no floor or ceiling effect and higher internal consistency than previous instruments, the SOSG-OQ has been recommended for assessment of quality of life in patients with MSCC.[80,81]

RT

Key considerations in delivering RT include the dose and fractionation and whether to re-irradiate in sites of prior RT.

RT dose and fractionation. Rades et al[82] examined outcomes of RT alone for MSCC with five different RT schedules: 8 Gy × 1, 4 Gy × 5, 3 Gy × 10, 2.5 Gy × 15, and 2 Gy × 20. There were no differences between arms in motor function improvement or post-treatment ambulatory rates. In-field recurrences at 2 years were greater in the shorter-course versus longer-course RT arms ($P < .001$): 24% to 26% (8 Gy × 1 and 4 Gy × 5) and 7% to 14% (2 Gy × 20, 2.5 Gy × 15, and 3 Gy × 10), respectively. These results were confirmed in a prospective study of 265 patients,[78] which suggests that shorter-course RT (eg, 8 Gy × 1) can be used in patients with a shorter-term prognosis (eg, less than 6 months), whereas longer courses

 © 2018 by American Society of Clinical Oncology

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

(eg, 3 Gy × 10) should be considered for patients with longer life expectancies.

Use of short-course RT in patients with a poorer prognosis is further supported by a randomized controlled trial of 4 Gy × 5 versus 3 Gy × 10 that found similar outcomes in both groups with respect to overall response, post-RT ambulatory status, progression-free survival, and overall survival (median survival, 3.2 months in the entire cohort).[83] A preliminary report of the SCORAD III noninferiority randomized controlled trial[84] of 8 Gy × 1 versus 4 Gy × 5 also supported the use of single-fraction RT in patients with a shorter-term prognosis (median survival, 3 months). The Patchell et al[7] study rendered use of 3 Gy × 10 as the default standard for postoperative management of MSCC. However, particularly among patients with a short prognosis (eg, less than 6 months), abbreviated RT courses often are considered.

Re-irradiation in the setting of MSCC. The limited data available[85-87] support the use of re-irradiation to the spine for recurrent MSCC if the risk of radiation myelopathy is low (ie, duration between RT courses of at least 6 months, cumulative biologic equivalent dose of less than or equal to 135.5 Gy_2 [cord $\alpha/\beta = 2$], and no course with a biologic equivalent dose of 102 Gy_2 or more). Highly conformal re-irradiation techniques after surgical decompression, such as SBRT, are considered in patients with a good prognosis to permit sufficient dose intensity to the tumor while sparing neural structures.

Rehabilitative Care

Rehabilitation after MSCC is shaped by the patient's goals, care requirements, and prognosis. Most patients with MSCC make functional gains comparable to those of patients with ischemic or traumatic spinal cord injury.[88,89] Key considerations include: rehabilitative care during acute hospitalization, management of neurogenic bladder and bowel, prevention of decubitus ulcers, and transition out of the acute care setting.

Rehabilitative care during acute hospitalization. During acute hospitalization, physical and occupational therapy optimize patients' function and clarify postdischarge needs. Progressive mobilization from bed to ambulation should begin as soon as is feasible to attenuate the preventable consequences of immobility. The physical and psychological benefits of enabling patients to spend time sitting and/or standing daily cannot be overstated.[90] Physical therapy staff select assistive devices to optimize safety and autonomy and orthotics to stabilize painful or unstable structures. Occupational therapy clinicians target task sequencing, fine motor dexterity, and pacing required for activities of daily living. A physical medicine and rehabilitation specialist coordinates and individualizes this care across disciplines and settings.

Management of bowel and bladder dysfunction. Neurogenic bowel and bladder pose threats to comfort, dignity, and health. The effect of MSCC on micturition depends on its location. Upper motor neuron lesions cause external sphincter hyper-reflexia and urinary retention, whereas lower motor neuron lesions cause sphincter flaccidity and incontinence. Patients with retention generally intermittently self-catheterize, whereas those with sphincter incontinence use regularly timed voiding and bladder retraining.

Bowel manifestations of MSCC also vary by lesion site. Upper motor neuron lesions cause sphincter hyper-reflexia and retention, whereas lower motor neuron lesions cause fecal incontinence. Bowel regimens for retention typically include osmotic agents (eg, polyethylene glycol) combined with motility agents (eg, senna). For fecal incontinence, bulking agents like psyllium are used. Evacuation schedules are highly individual and generally reflect a balance among convenience, comfort, and continence.

Prevention of decubitus ulcers. Patients with severely compromised sensation require protective mattress overlays or alternate pressure-relieving bedding as well as regular weight shifts to protect areas prone to breakdown, including the calcanei and ischial tuberosities. Patients and caregivers are taught how to inspect insensate areas and identify early signs of skin breakdown.

Transitioning out of the acute care setting. Post–acute care rehabilitation services can be delivered in the home, inpatient rehabilitation facility (IRF), or skilled nursing facility (SNF). The optimal setting depends on a patient's care requirements, need for physician oversight, prognosis, and goals. IRFs and SNFs differ in cost, service intensity, and participation expectations. Patients in IRFs participate in 3 hours of therapy per day at least 5 days per week. Care is provided by a multidisciplinary team with physician supervision. In contrast, SNFs require only 1 hour of therapy per day, 5 days per week. Given the increased cost of IRFs relative to SNFs, payer approvals depend on demonstration of rehabilitation goals that require IRF-level care and a high likelihood of discharge to home. Such goals may include recovery of autonomous mobility and capacity for activities of daily living performance, caregiver training on durable medical equipment, and management of neurogenic bowel or bladder.

Psychosocial Concerns and Palliative Care

Psychosocial concerns of patients with MSCC include coping, family and caregiving needs, and advance care planning. Patients may express worries about reduced mobility, increased caregiving burden on loved ones, and barriers to receiving care at home.[91,92] They frequently face concerns about limitations on their social lives and fear of being viewed as disabled in social settings.[91-93] In addition, patients must manage uncertainty about their functional recovery and overall prognosis.[91]

Oncologists can collaborate with psychosocial and palliative care clinicians to explore patients' coping, fears, and care preferences as the disease progresses.[11] A list of

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

Questions with regard to function

- What is your typical day like?
- What things do you need to get done?
- What do you really enjoy doing?
- Have you ever needed help to take care of yourself? How did you deal with that?
- Who is home to help during the day and overnight?

Questions with regard to coping

- What is most difficult about this experience?
- What gives you strength as you go through this illness?
- Upon whom do you rely for support?
- Do you consider yourself spiritual or religious?
- Are you part of a spiritual or religious community? Is this community of support to you?

Questions with regard to goals and decision making

- What is your understanding of where you are with your cancer?
- As you think about the future, what are your most important goals? *Or*: If time were shorter than we hoped, what would feel most important?
- As you think about the future, what fears and worries do you have?
- With whom do you talk about important issues related to your health?
- Have you identified a health care proxy? *If no*: Is there someone who really understands what is important to you and how you make decisions? If you were not able to tell us directly what you wanted, may we talk with them?

FIG 3. Assessment of psychosocial concerns and goals of care in patients with metastatic spinal cord compression.[11,94,95]

helpful assessment questions is shown in Figure 3. Social workers provide therapeutic counseling to help patients to process changes in independence and caregiving needs and to manage uncertainty about the future. Patients with significant anxiety or depressive symptoms may benefit from referral to a psychiatrist experienced in caring for patients with advanced cancer. In addition to managing symptoms, palliative care specialists can help patients to elucidate their treatment goals and weigh therapeutic options in the context of these goals.

Multidisciplinary Management

A multidisciplinary team approach is an established component of quality cancer care[86] and can be used for decision making for patients with MSCC. A multidisciplinary tumor board facilitates involvement of all relevant clinicians, streamlines care for complicated patients, decreases practice variation, and promotes a unified voice in creating the patient's care plan.[96,97] Although high-quality evidence is limited, multidisciplinary care, such as a multidisciplinary tumor board, has been associated with improved evidence-based decision making and clinical outcomes.[98,99]

Similarly, a multidisciplinary spinal tumor conference is useful to guide management of patients with spinal metastases, including MSCC. Medical and radiation oncologists, radiologists, spine surgeons, palliative care specialists, and psychosocial providers discuss the appropriateness of surgical or procedural interventions, timing and details of RT, strategies for pain management, and how these therapies affect plans for systemic treatment. Case discussions include relevant psychosocial factors and the patient's goals. Although to our knowledge the effect of a multidisciplinary spinal tumor conference on clinical outcomes has not been studied, it is a valuable forum at the Dana-Farber/Brigham and Women's Cancer Center to guide management of patients with MSCC.

In conclusion, MSCC can be a catastrophic manifestation of advanced cancer that causes immobilizing pain and the risk of irreversible neurologic impairment. Initial management includes glucocorticoids and pain control while RT and potential surgical interventions are planned. Key factors in choosing upfront surgery include spinal stability, neurologic deficits, and the patient's prognosis, goals, and quality of life. Support for psychosocial and rehabilitation concerns is critical to help patients to adjust to changes in level of function and independence. Regular collaboration among multidisciplinary providers from initial treatment planning onward optimizes the patient's independence, symptom control, and achievement of treatment goals.

AFFILIATIONS

[1]Dana-Farber Cancer Institute, Boston, MA
[2]Brigham and Women's Hospital, Boston, MA
[3]Mayo Clinic, Rochester, MN
[4]University Hospital of Lübeck, Lübeck, Germany

CORRESPONDING AUTHOR

Andrew J. Lawton, MD, Division of Adult Palliative Care, Department of Psychosocial Oncology and Palliative Care, Dana-Farber Cancer Institute, 450 Brookline Ave, DA 2016A, Boston, MA 02215; e-mail: andrewj_lawton@dfci.harvard.edu.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST AND DATA AVAILABILITY STATEMENT

Disclosures provided by the authors and data availability statement (if applicable) are available with this article at DOI https://doi.org/10.1200/JCO.2018.78.1211.

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

AUTHOR CONTRIBUTIONS

Conception and design: Andrew J. Lawton, Kathleen A. Lee, Andrea L. Cheville, Marco L. Ferrone, Tracy A. Balboni, Janet L. Abrahm

Collection and assembly of data: All authors

Data analysis and interpretation: All authors

Manuscript writing: All authors

Final approval of manuscript: All authors

Accountable for all aspects of the work: All authors

REFERENCES

1. Levack P, Graham J, Collie D, et al: Don't wait for a sensory level–listen to the symptoms: A prospective audit of the delays in diagnosis of malignant cord compression. Clin Oncol (R Coll Radiol) 14:472-480, 2002
2. Loblaw DA, Laperriere NJ, Mackillop WJ: A population-based study of malignant spinal cord compression in Ontario. Clin Oncol (R Coll Radiol) 15:211-217, 2003
3. Mak KS, Lee LK, Mak RH, et al: Incidence and treatment patterns in hospitalizations for malignant spinal cord compression in the United States, 1998-2006. Int J Radiat Oncol Biol Phys 80:824-831, 2011
4. Bach F, Larsen BH, Rohde K, et al: Metastatic spinal cord compression. Occurrence, symptoms, clinical presentations and prognosis in 398 patients with spinal cord compression. Acta Neurochir (Wien) 107:37-43, 1990
5. Husband DJ: Malignant spinal cord compression: Prospective study of delays in referral and treatment. BMJ 317:18-21, 1998
6. Schiff D, O'Neill BP, Suman VJ: Spinal epidural metastasis as the initial manifestation of malignancy: Clinical features and diagnostic approach. Neurology 49: 452-456, 1997
7. Patchell RA, Tibbs PA, Regine WF, et al: Direct decompressive surgical resection in the treatment of spinal cord compression caused by metastatic cancer: A randomised trial. Lancet 366:643-648, 2005
8. Laufer I, Rubin DG, Lis E, et al: The NOMS framework: Approach to the treatment of spinal metastatic tumors. Oncologist 18:744-751, 2013
9. Gilbert RW, Kim JH, Posner JB: Epidural spinal cord compression from metastatic tumor: Diagnosis and treatment. Ann Neurol 3:40-51, 1978
10. Loblaw DA, Perry J, Chambers A, et al: Systematic review of the diagnosis and management of malignant extradural spinal cord compression: The Cancer Care Ontario Practice Guidelines Initiative's Neuro-Oncology Disease Site Group. J Clin Oncol 23:2028-2037, 2005
11. Abrahm JL, Banffy MB, Harris MB: Spinal cord compression in patients with advanced metastatic cancer: "All I care about is walking and living my life". JAMA 299:937-946, 2008
12. Huang J, Jatoi A: Morbidity and mortality in patients with cancer who become nonambulatory after spinal cord compression: A case series on end-of-life care. J Palliat Med 12:219-222, 2009
13. Prasad D, Schiff D: Malignant spinal-cord compression. Lancet Oncol 6:15-24, 2005
14. Molloy S, Lai M, Pratt G, et al: Optimizing the management of patients with spinal myeloma disease. Br J Haematol 171:332-343, 2015
15. Helweg-Larsen S, Sørensen PS: Symptoms and signs in metastatic spinal cord compression: A study of progression from first symptom until diagnosis in 153 patients. Eur J Cancer 30:396-398, 1994
16. Pigott KH, Baddeley H, Maher EJ: Pattern of disease in spinal cord compression on MRI scan and implications for treatment. Clin Oncol (R Coll Radiol) 6:7-10, 1994
17. Cole JS, Patchell RA: Metastatic epidural spinal cord compression. Lancet Neurol 7:459-466, 2008
18. Abrahm JL: A Physician's Guide to Pain and Symptom Management in Cancer Patients (ed 3). Baltimore, MD, Johns Hopkins University Press, 2014
19. Sciubba DM, Petteys RJ, Dekutoski MB, et al: Diagnosis and management of metastatic spine disease. A review. J Neurosurg Spine 13:94-108, 2010
20. Coleman RE: Metastatic bone disease: Clinical features, pathophysiology and treatment strategies. Cancer Treat Rev 27:165-176, 2001
21. Harel R, Angelov L: Spine metastases: Current treatments and future directions. Eur J Cancer 46:2696-2707, 2010
22. Sun H, Nemecek AN: Optimal management of malignant epidural spinal cord compression. Hematol Oncol Clin North Am 24:537-551, 2010
23. Cook AM, Lau TN, Tomlinson MJ, et al: Magnetic resonance imaging of the whole spine in suspected malignant spinal cord compression: Impact on management. Clin Oncol (R Coll Radiol) 10:39-43, 1998
24. Sørensen S, Helweg-Larsen S, Mouridsen H, et al: Effect of high-dose dexamethasone in carcinomatous metastatic spinal cord compression treated with radiotherapy: A randomised trial. Eur J Cancer 30:22-27, 1994
25. Helweg-Larsen S: Clinical outcome in metastatic spinal cord compression. A prospective study of 153 patients. Acta Neurol Scand 94:269-275, 1996
26. Rades D, Abrahm JL: The role of radiotherapy for metastatic epidural spinal cord compression. Nat Rev Clin Oncol 7:590-598, 2010
27. Li KC, Poon PY: Sensitivity and specificity of MRI in detecting malignant spinal cord compression and in distinguishing malignant from benign compression fractures of vertebrae. Magn Reson Imaging 6:547-556, 1988
28. Venkitaraman R, Sohaib SA, Barbachano Y, et al: Detection of occult spinal cord compression with magnetic resonance imaging of the spine. Clin Oncol (R Coll Radiol) 19:528-531, 2007
29. Schiff D, O'Neill BP, Wang CH, et al: Neuroimaging and treatment implications of patients with multiple epidural spinal metastases. Cancer 83:1593-1601, 1998
30. Husband DJ, Grant KA, Romaniuk CS: MRI in the diagnosis and treatment of suspected malignant spinal cord compression. Br J Radiol 74:15-23, 2001
31. Carmody RF, Yang PJ, Seeley GW, et al: Spinal cord compression due to metastatic disease: Diagnosis with MR imaging versus myelography. Radiology 173: 225-229, 1989
32. Hagenau C, Grosh W, Currie M, et al: Comparison of spinal magnetic resonance imaging and myelography in cancer patients. J Clin Oncol 5:1663-1669, 1987
33. Goldstein NE, Morrison RS: Evidence-Based Practice of Palliative Medicine (ed 1). Philadelphia, PA, Elsevier Saunders, 2013
34. Kamoto Y, Sadato N, Yonekura Y, et al: Visualization of the cervical spinal cord with FDG and high-resolution PET. J Comput Assist Tomogr 22:487-491, 1998
35. Baba H, Uchida K, Sadato N, et al: Potential usefulness of ^{18}F-2-fluoro-deoxy-D-glucose positron emission tomography in cervical compressive myelopathy. Spine 24:1449-1454, 1999
36. Loblaw DA, Mitera G, Ford M, et al: A 2011 updated systematic review and clinical practice guideline for the management of malignant extradural spinal cord compression. Int J Radiat Oncol Biol Phys 84:312-317, 2012
37. Graham PH, Capp A, Delaney G, et al: A pilot randomised comparison of dexamethasone 96 mg vs 16 mg per day for malignant spinal-cord compression treated by radiotherapy: TROG 01.05 Superdex study. Clin Oncol (R Coll Radiol) 18:70-76, 2006

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

38. George R, Jeba J, Ramkumar G, et al: Interventions for the treatment of metastatic extradural spinal cord compression in adults. Cochrane Database Syst Rev (9):CD006716, 2015
39. Patchell RA: Metastatic epidural spinal cord compression. Eur J Cancer Suppl 5:35-40, 2007
40. Ropper AE, Ropper AH: Acute spinal cord compression. N Engl J Med 376:1358-1369, 2017
41. Kumar A, Weber MH, Gokaslan Z, et al: Metastatic spinal cord compression and steroid treatment: A systematic review. Clin Spine Surg 30:156-163, 2017
42. Dworkin RH, O'Connor AB, Backonja M, et al: Pharmacologic management of neuropathic pain: Evidence-based recommendations. Pain 132:237-251, 2007
43. Tai Q, Kirshblum S, Chen B, et al: Gabapentin in the treatment of neuropathic pain after spinal cord injury: A prospective, randomized, double-blind, crossover trial. J Spinal Cord Med 25:100-105, 2002
44. Siddall PJ, Cousins MJ, Otte A, et al: Pregabalin in central neuropathic pain associated with spinal cord injury: A placebo-controlled trial. Neurology 67: 1792-1800, 2006
45. Mercadante S, Arcuri E, Tirelli W, et al: Amitriptyline in neuropathic cancer pain in patients on morphine therapy: A randomized placebo-controlled, double-blind crossover study. Tumori 88:239-242, 2002
46. Wong R, Wiffen PJ: Bisphosphonates for the relief of pain secondary to bone metastases. Cochrane Database Syst Rev (2):CD002068, 2002
47. Tarumi Y, Wilson MP, Szafran O, et al: Randomized, double-blind, placebo-controlled trial of oral docusate in the management of constipation in hospice patients. J Pain Symptom Manage 45:2-13, 2013
48. Fehlings MG, Nater A, Tetreault L, et al: Survival and clinical outcomes in surgically treated patients with metastatic epidural spinal cord compression: Results of the prospective multicenter AOSpine study. J Clin Oncol 34:268-276, 2016
49. Ibrahim A, Crockard A, Antonietti P, et al: Does spinal surgery improve the quality of life for those with extradural (spinal) osseous metastases? An international multicenter prospective observational study of 223 patients. Invited submission from the Joint Section Meeting on Disorders of the Spine and Peripheral Nerves, March 2007. J Neurosurg Spine 8:271-278, 2008
50. Wu J, Zheng W, Xiao JR, et al: Health-related quality of life in patients with spinal metastases treated with or without spinal surgery: A prospective, longitudinal study. Cancer 116:3875-3882, 2010
51. Sadeghi-Naini M, Aarabi S, Shokraneh F, et al: Vertebroplasty and kyphoplasty for metastatic spinal lesions: A systematic review. Clin Spine Surg, 31:203-210, 2018
52. Health Quality Ontario: Vertebral augmentation involving vertebroplasty or kyphoplasty for cancer-related vertebral compression fractures: A systematic review. Ont Health Technol Assess Ser 16:1-202, 2016
53. Fisher CG, DiPaola CP, Ryken TC, et al: A novel classification system for spinal instability in neoplastic disease: An evidence-based approach and expert consensus from the Spine Oncology Study Group. Spine 35:E1221-E1229, 2010
54. Bilsky MH, Laufer I, Fourney DR, et al: Reliability analysis of the Epidural Spinal Cord Compression Scale. J Neurosurg Spine 13:324-328, 2010
55. Schoenfeld AJ, Le HV, Marjoua Y, et al: Assessing the utility of a clinical prediction score regarding 30-day morbidity and mortality following metastatic spinal surgery: The New England Spinal Metastasis Score (NESMS). Spine J 16:482-490, 2016
56. Viganò A, Dorgan M, Bruera E, et al: The relative accuracy of the clinical estimation of the duration of life for patients with end of life cancer. Cancer 86:170-176, 1999
57. Chow E, Harth T, Hruby G, et al: How accurate are physicians' clinical predictions of survival and the available prognostic tools in estimating survival times in terminally ill cancer patients? A systematic review. Clin Oncol (R Coll Radiol) 13:209-218, 2001
58. Clément-Duchêne C, Carnin C, Guillemin F, et al: How accurate are physicians in the prediction of patient survival in advanced lung cancer? Oncologist 15: 782-789, 2010
59. Hølmebakk T, Solbakken A, Mala T, et al: Clinical prediction of survival by surgeons for patients with incurable abdominal malignancy. Eur J Surg Oncol 37: 571-575, 2011
60. Kondziolka D, Parry PV, Lunsford LD, et al: The accuracy of predicting survival in individual patients with cancer. J Neurosurg 120:24-30, 2014
61. Verlaan JJ, Choi D, Versteeg A, et al: Characteristics of patients who survived < 3 months or > 2 years after surgery for spinal metastases: Can we avoid inappropriate patient selection? J Clin Oncol 34:3054-3061, 2016
62. Nater A, Martin AR, Sahgal A, et al: Symptomatic spinal metastasis: A systematic literature review of the preoperative prognostic factors for survival, neurological, functional and quality of life in surgically treated patients and methodological recommendations for prognostic studies. PLoS One 12:e0171507, 2017
63. Leithner A, Radl R, Gruber G, et al: Predictive value of seven preoperative prognostic scoring systems for spinal metastases. Eur Spine J 17:1488-1495, 2008
64. Wibmer C, Leithner A, Hofmann G, et al: Survival analysis of 254 patients after manifestation of spinal metastases: Evaluation of seven preoperative scoring systems. Spine 36:1977-1986, 2011
65. Paulino Pereira NR, Janssen SJ, van Dijk E, et al: Development of a prognostic survival algorithm for patients with metastatic spine disease. J Bone Joint Surg Am 98:1767-1776, 2016
66. Paulino Pereira NR, Mclaughlin L, Janssen SJ, et al: The SORG nomogram accurately predicts 3- and 12-months survival for operable spine metastatic disease: External validation. J Surg Oncol 115:1019-1027, 2017
67. Bartels RH, Feuth T, Rades D, et al: External validation of a model to predict the survival of patients presenting with a spinal epidural metastasis. Cancer Metastasis Rev 30:153-159, 2011
68. Bartels RH, de Ruiter G, Feuth T, et al: Prediction of life expectancy in patients with spinal epidural metastasis. Neuro-oncol 18:114-118, 2016
69. van den Bent MJ: Surgical resection improves outcome in metastatic epidural spinal cord compression. Lancet 366:609-610, 2005
70. Kunkler I: Surgical resection in metastatic spinal cord compression. Lancet 367:109, 2006; author reply 109-110
71. Knisely J, Strugar J: Can decompressive surgery improve outcome in patients with metastatic epidural spinal-cord compression? Nat Clin Pract Oncol 3:14-15, 2006
72. Rades D, Huttenlocher S, Dunst J, et al: Matched pair analysis comparing surgery followed by radiotherapy and radiotherapy alone for metastatic spinal cord compression. J Clin Oncol 28:3597-3604, 2010
73. Rades D, Huttenlocher S, Bajrovic A, et al: Surgery followed by radiotherapy versus radiotherapy alone for metastatic spinal cord compression from unfavorable tumors. Int J Radiat Oncol Biol Phys 81:e861-e868, 2011
74. Barzilai O, Laufer I, Yamada Y, et al: Integrating evidence-based medicine for treatment of spinal metastases into a decision framework: Neurologic, oncologic, mechanicals stability, and systemic disease. J Clin Oncol 35:2419-2427, 2017
75. Lee I, Omodon M, Rock J, et al: Stereotactic radiosurgery for high-grade metastatic epidural cord compression. J Radiosurg SBRT 3:51-58, 2014
76. Moussazadeh N, Laufer I, Yamada Y, et al: Separation surgery for spinal metastases: Effect of spinal radiosurgery on surgical treatment goals. Cancer Contr 21: 168-174, 2014

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

77. Laufer I, Iorgulescu JB, Chapman T, et al: Local disease control for spinal metastases following "separation surgery" and adjuvant hypofractionated or high-dose single-fraction stereotactic radiosurgery: Outcome analysis in 186 patients. J Neurosurg Spine 18:207-214, 2013
78. Rades D, Lange M, Veninga T, et al: Final results of a prospective study comparing the local control of short-course and long-course radiotherapy for metastatic spinal cord compression. Int J Radiat Oncol Biol Phys 79:524-530, 2011
79. Garg AK, Shiu AS, Yang J, et al: Phase 1/2 trial of single-session stereotactic body radiotherapy for previously unirradiated spinal metastases. Cancer 118: 5069-5077, 2012
80. Janssen SJ, Teunis T, van Dijk E, et al: Validation of the Spine Oncology Study Group-Outcomes Questionnaire to assess quality of life in patients with metastatic spine disease. Spine J 17:768-776, 2017
81. Paulino Pereira NR, Janssen SJ, Raskin KA, et al: Most efficient questionnaires to measure quality of life, physical function, and pain in patients with metastatic spine disease: A cross-sectional prospective survey study. Spine J 17:953-961, 2017
82. Rades D, Stalpers LJ, Veninga T, et al: Evaluation of five radiation schedules and prognostic factors for metastatic spinal cord compression. J Clin Oncol 23: 3366-3375, 2005
83. Maranzano E, Bellavita R, Rossi R, et al: Short-course versus split-course radiotherapy in metastatic spinal cord compression: Results of a phase III, randomized, multicenter trial. J Clin Oncol 23:3358-3365, 2005
84. Hoskin P, Misra V, Hopkins K, et al: SCORAD III: Randomized noninferiority phase III trial of single-dose radiotherapy (RT) compared to multifraction RT in patients (pts) with metastatic spinal canal compression (SCC). J Clin Oncol 35, 2017 (suppl, abstr LBA10004)
85. Nieder C, Grosu AL, Andratschke NH, et al: Proposal of human spinal cord reirradiation dose based on collection of data from 40 patients. Int J Radiat Oncol Biol Phys 61:851-855, 2005
86. Nieder C, Grosu AL, Andratschke NH, et al: Update of human spinal cord reirradiation tolerance based on additional data from 38 patients. Int J Radiat Oncol Biol Phys 66:1446-1449, 2006
87. Sahgal A, Ma L, Weinberg V, et al: Reirradiation human spinal cord tolerance for stereotactic body radiotherapy. Int J Radiat Oncol Biol Phys 82:107-116, 2012
88. Huang ME, Sliwa JA: Inpatient rehabilitation of patients with cancer: Efficacy and treatment considerations. PM R 3:746-757, 2011
89. McKinley WO, Huang ME, Brunsvold KT: Neoplastic versus traumatic spinal cord injury: An outcome comparison after inpatient rehabilitation. Arch Phys Med Rehabil 80:1253-1257, 1999
90. Hicks AL, Ginis KA: Treadmill training after spinal cord injury: It's not just about the walking. J Rehabil Res Dev 45:241-248, 2008
91. Warnock C, Tod A: A descriptive exploration of the experiences of patients with significant functional impairment following a recent diagnosis of metastatic spinal cord compression. J Adv Nurs 70:564-574, 2014
92. Harris M: Quality of life in patients with malignant spinal cord compression: A review of evidence-based literature. Int J Palliat Nurs 22:37-43, 2016
93. Eva G, Paley J, Miller M, et al: Patients' constructions of disability in metastatic spinal cord compression. Palliat Med 23:132-140, 2009
94. Bernacki R, Hutchings M, Vick J, et al: Development of the Serious Illness Care Program: A randomised controlled trial of a palliative care communication intervention. BMJ Open 5:e009032, 2015
95. Borneman T, Ferrell B, Puchalski CM: Evaluation of the FICA Tool for Spiritual Assessment. J Pain Symptom Manage 40:163-173, 2010
96. El Saghir NS, Keating NL, Carlson RW, et al: Tumor boards: Optimizing the structure and improving efficiency of multidisciplinary management of patients with cancer worldwide. Am Soc Clin Oncol Educ Book 34:e461-e466, 2014
97. Heineman T, St John MA, Wein RO, et al: It takes a village: The importance of multidisciplinary care. Otolaryngol Clin North Am 50:679-687, 2017
98. Taylor C, Munro AJ, Glynne-Jones R, et al: Multidisciplinary team working in cancer: What is the evidence? BMJ 340:c951, 2010
99. Agarwal PD, Phillips P, Hillman L, et al: Multidisciplinary management of hepatocellular carcinoma improves access to therapy and patient survival. J Clin Gastroenterol 51:845-849, 2017

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Assessment and Management of Patients With Metastatic Spinal Cord Compression: A Multidisciplinary Review

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or ascopubs.org/jco/site/ifc.

Andrew J. Lawton
Stock or Other Ownership: Abbott Laboratories, Bristol-Myers Squibb, Celgene

Dirk Rades
Honoraria: Elsevier
Research Funding: Merck Serono (Inst)

Janet L. Abrahm
Consulting or Advisory Role: Novartis, Pfizer
Patents, Royalties, Other Intellectual Property: Royalties from UpToDate and Johns Hopkins University Press
Travel, Accommodations, Expenses: Novartis, Pfizer

No other potential conflicts of interest were reported.

© 2018 by American Society of Clinical Oncology

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.

APPENDIX

TABLE A1. Search Strategy for Review of the MEDLINE Database Through PubMed

Strategy No.	MeSH, Subheading, and Free-Text Search Terms
1	Spinal cord compression (MeSH)
2	Spinal cord compression
3	Extramedullary compression
4	Medulla compression
5	Medullary compression
6	1 or 2…5 (spinal cord compression)
7	Neoplasm Metastasis (MeSH)
8	Neoplasm metastasis
9	Metastatic neoplasm
10	Cancer metastasis
11	Metastatic cancer
12	7 or 8…11 (neoplasm metastasis)
13	6 and 12 (spinal cord compression and neoplasm metastasis)

Abbreviation: MeSH, Medical Subject Heading.

Downloaded from ascopubs.org by Dr. Janet Abrahm on July 11, 2023 from 073.253.052.033
Copyright © 2023 American Society of Clinical Oncology. All rights reserved.