

Surgical Management of Metastatic Disease of the Spine

The incidence of metastatic spine disease is increasing with rising cancer incidence and improved treatment. 5-10% of patients with cancer develop spinal metastases and 10% of these develop cord compression.¹ Treatment options for metastatic spinal disease include radiotherapy, surgery, hormone therapy and chemotherapy.

The objectives of management are to treat the patient's pain and disability. To best do this, the nature of the patient's spinal problem must be thoroughly assessed. Once this assessment has been made, potential surgical solutions can be considered. These need to be evaluated in the context of the individual patient's circumstances: how fit are they, what is the likely course of their disease and what other options for intervention are available? These complex decisions are best made within a multi-disciplinary team.

Pathology

Primary tumours of the prostate, lung and breast most commonly metastasise to the spine, accounting for about 50% of epidural compression cases. Other common primary cancers include lymphoma, melanoma, renal cell carcinoma, sarcoma and multiple myeloma.² The most frequently affected part of the vertebra is the body (see Figures 1a and 1c), followed by the pedicles and posterior elements. More than 90% of spinal metastases are extradural, 5% are intradural and <1% intramedullary.³

Metastatic tumour growing into the spinal canal can cause spinal cord damage by direct compression resulting in oedema, venous congestion and demyelination. With prolonged compression, secondary vascular injury occurs with capillary or venous occlusion and/or infiltration followed by infarction of the spinal cord. The metastatic infiltration of bone can cause pain with or without frank

instability. Destruction of the vertebral body can lead to a pathological fracture and progressive kyphotic deformity. Such deformity further threatens a spinal cord that may already be compromised by tumour within the spinal canal (see Figure 1c). Radiculopathy may ensue as a result of exiting nerve roots being compressed.

Presentation

History

Patients at increased risk of spinal metastases are those with known malignancy and those aged over 50. Spinal pain is the main presenting symptom in 85% of spinal tumours. However, back pain is a common complaint and malignant disease will only be responsible for a minority of all back pain.

Red flag features of pain that increase the likelihood of serious spinal disease are:-

- Gradual onset, progressive, constant, night-time or recumbency pain and axial pain exacerbated by movement in all planes.⁴

The pain may be accompanied by a progressive neurological deficit, deformity or unexplained constitutional symptoms. These symptoms are important to elicit as they may have a bearing on subsequent decision making.

Examination

The neurological findings depend on the site and level of the lesion. As most spinal metastases begin in the vertebral body, anterior cord compression involving the corticospinal tracts causing spastic paraparesis, is the most common initial neurological deficit. It is important to establish whether the patient can walk. Examination of the supine patient may reveal good lower limb power but the patient may be unable to weight bear. Whilst the patient is upright, check for any visible kyphotic deformity secondary to vertebral body collapse or localised bony tenderness. Sensory and sphincter disturbances tend to present later.

Investigations

Laboratory tests are helpful in assessing the patient's fitness for surgery but infrequently aid the diagnostic process, haematological malignancy being the notable exception. However, if metastatic spinal disease is suspected, FOB, PSA, CEA and urine and serum electrophoresis may be helpful in determining the primary lesion. A raised transaminase in the LFTs raises the suspicion of liver metastases.

An MRI scan is crucial to aid diagnosis and delineate the extent of the spinal disease. The initial scan may focus on the part of the spine from where the patient's symptoms seem to



Catherine Gilkes is a specialist registrar in neurosurgery at Derriford hospital, Plymouth. She trained at Cambridge and Edinburgh Universities and is currently in her third year of training on the south-west neurosurgery rotation.



Tim Germon completed Neurosurgical training and MD in Bristol. He then spent a year as the first neurosurgeon to complete the national orthopaedic spine fellowship in Nottingham. He was appointed as a Consultant Neurosurgeon in 2000 and his practice is now entirely spinal.

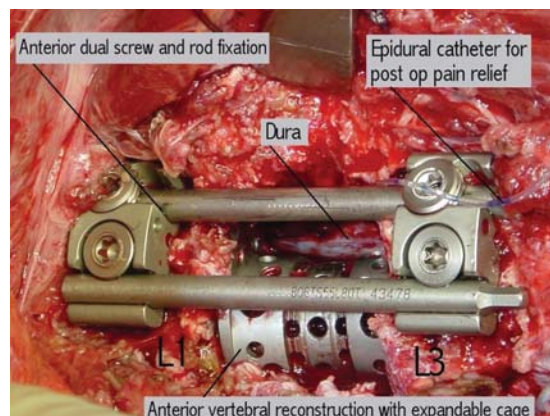
Correspondence to:

Mr Tim Germon,
consultant neurosurgeon
South West Neurosurgery Centre,
Derriford Hospital
Plymouth
PL6 8DH
Email: tim.germon@
phnt.swest.nhs.uk

Figure 1a.



Figure 1b.



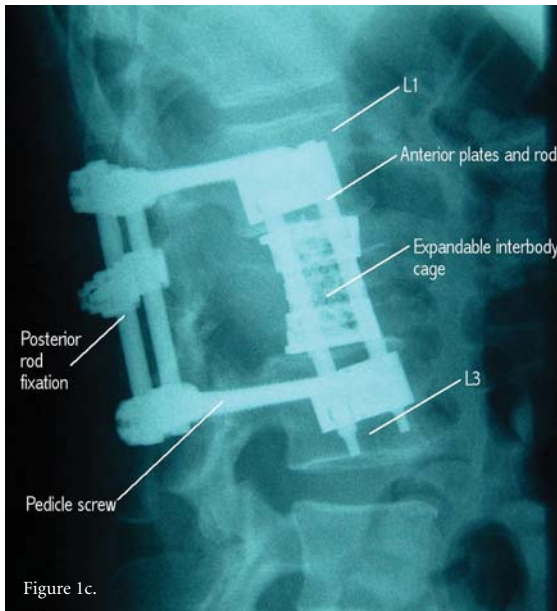


Figure 1c.

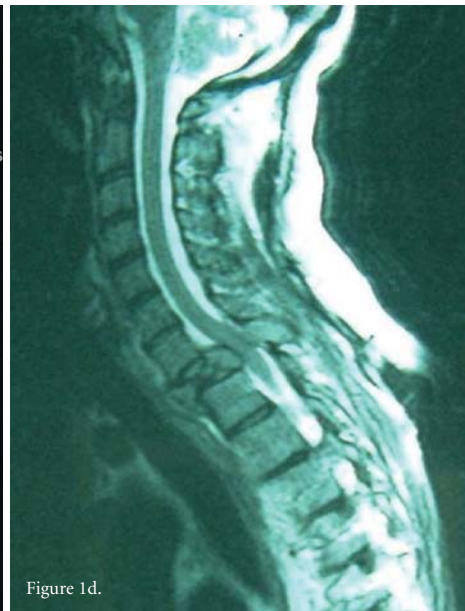


Figure 1d.

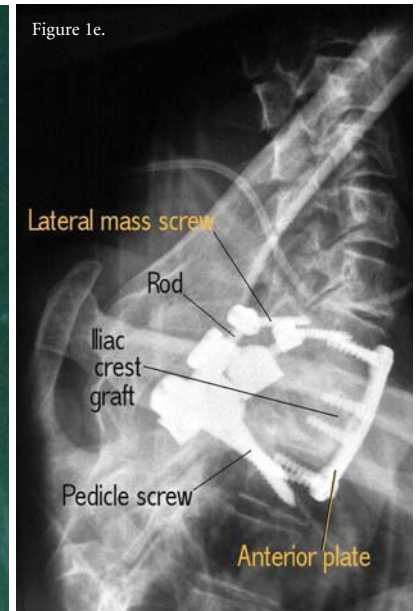


Figure 1e.

be arising. However, if metastatic disease is discovered, the whole spine must be imaged. If the MRI cannot be tolerated or is contraindicated, a myelogram can be used to establish the level of compression. Although the T2 weighted image is generally the most sensitive sequence to detect pathological change, the T1 sequence is often best to identify metastases. If contrast is given, the metastases may be rendered isointense and thus not seen on a T1 + gadolinium image. Similarly, the increased T2 signal of pathological tissue may be isointense with the fatty bone marrow masking the appearance of metastases on a T2 sequence. A fat suppressed T2 scan is therefore often useful.

Plain x-rays often serve as the initial screening test as they are readily available. They are poor at detecting lytic metastases, since up to 50% of the bone must be destroyed. However, they are the best modality for assessing and monitoring deformity and for identifying sclerotic lesions.

CT scanning may be helpful to determine the amount of bony destruction that has occurred, and for the assessment of potential bony fixation points if reconstruction is being considered.

Bone scans are sensitive for detecting early stage bone pathology. However they lack specificity and are largely restricted to assessing the extra-axial skeleton and cases where diagnostic doubt prevails.

Management Options

The therapeutic objectives in the management of metastatic disease of the spine are to:-

1. Maintain and restore neurological function
2. Treat pain

Surgery can obtain these therapeutic objectives by:

1. Decompression of neural elements
2. Restoration and maintenance of the alignment and integrity of the spinal column

Surgical strategies

Instrumentation and fusion

Traditionally a decompressive laminectomy was the surgical option in metastatic spinal

disease. This may satisfy some of the therapeutic objectives by indirectly decompressing the cord or cauda equina but deformity will develop without surgical stabilisation, increasing pain and neurological deficit. The use of instrumentation allows realignment and stabilisation of the spine and consequently a more aggressive decompression and tumour resection (see Figure 1b, 1c and 1e). Those patients with neurology secondary to deformity will not improve without realignment.⁵ Instrumentation includes:

1. Fixation using rods and screws. In the cervical spine, screws are placed in the lateral masses. In the thoracolumbar spine pedicle screws are normally used.
2. Vertebral body reconstruction. This may be with a metal cage, cement, ceramic spacer or iliac crest graft.

Implants have a finite life span, and will eventually fail. Since this is palliative surgery, the life expectancy of the instrumentation may well be longer than that of the patient. With increased longevity, measures must be taken to achieve bony union, to avoid instrument failure. The extent of instrumentation depends on the extent of metastasis, condition of the bone and the extent of the deformity.

Surgical Approach

Most spinal pathology can be managed using an anterior or a posterior approach. Sometimes a combined anterior and posterior approach is required (Figure 1b, 1c and 1e). The factors to consider are 1) the part of the spine affected, 2) the anatomy of the cord compression, 3) any deformity and 4) the general condition of the patient. In the thoracolumbar spine, posterior instrumentation involves the insertion of pedicle screws providing good bone purchase and allowing the correction of deformity. Whilst vertebral body reconstruction can be performed from a posterior approach,⁶ it is easier if the vertebral body is accessed anteriorly. However, anterior fixation is not as reliable as pedicle screw fixation, particularly in patients with poor

bone quality. In addition, the patient's respiratory function may preclude a thoracotomy or retroperitoneal approach to the vertebral body.

Extent of resection

Surgery for metastatic disease cannot be curative. The main aim is to provide a direct decompression of the spinal cord, removing as much tumour as feasible to reduce the risk of local recurrence, particularly when a chemo and radioresistant tumour is being treated, such as renal cell carcinoma.

Adjuvant therapy

All but emergency cases should be discussed in the context of a multidisciplinary team. A decision to proceed with initial radiation therapy should be made in the knowledge that this will increase the risk of wound infection by as much as a factor of three⁷ should the patient come to surgery. Surgery should not be undertaken during the post-chemotherapy period of immune and haemopoietic compromise.

Embolisation

Metastatic tumours of thyroid and renal cell origin are notoriously vascular. Preoperative embolisation reduces the intraoperative blood loss.

Surgery versus radiotherapy

The relative roles of surgery and radiotherapy have been the subject of much debate. There is now class 1 evidence that appropriate surgery, followed by radiotherapy, is the treatment of choice in selected patients with symptomatic spinal metastases. Patchell et al⁸ included 101 'acceptable surgical candidates' with a single level of metastatic epidural spinal cord compression, at least one associated sign or symptom including pain and at least three months life expectancy. Patients with very radiosensitive tumours and those that had been paraplegic for at least 48 hours were excluded. All patients were given dexamethasone and were randomised to radiotherapy or surgery followed by radiotherapy. The two groups were evenly matched in terms of primary tumour types, neurology, tumour loca-

tions and spinal instability. The most common primary tumours were lung (26 patients) and prostate (19 patients). The thoracic spine (88 patients) was the commonest site of disease. The vertebral body was involved in 61 patients. No lumbar lesions were included. 32 patients were unable to walk and 39 patients were incontinent preoperatively. Surgery with radiotherapy resulted in better neurological function, better pain control and increased longevity compared with radiotherapy alone. The post treatment ambulation rate was 84% in the surgery group and 57% in the radiation group. Of those unable to walk preoperatively, 62% regained the ability to walk following surgery compared with 19% of the radiation group. Those patients receiving surgery remained ambulant for longer, in most cases for the remainder of their lives. The major disadvantages of surgery are that the patient must be fit enough to tolerate it and their life expectancy must be sufficient to justify the extent of the proposed surgery.

Factors contributing to the decision making process include:

Attitude of patient

This is ultimately the most important factor. The risks and benefits of surgery and conservative treatment must be discussed frankly with the patient. Having been fully informed, most individuals are able to make their own decision as to which treatment strategy they would prefer.

Neurological status

If the neurology is rapidly progressing, a complete irreversible cord lesion may supervene before radiotherapy has any effect. Surgery is the most expedient means of decompressing the neural elements. Whilst it is well documented that the preoperative Frankel grade is a strong predictor of functional outcome,⁷ our experience is that surgical decompression and reconstruction of the spinal column is very effective in restoring spinal cord function despite the severity of the lesion. In our series of 14 immobile patients (Frankel grades A, B and C) treated surgically for spinal cord compression, 12 became mobile (Frankel grades D and E) and two remained unchanged.⁹ In a retrospective review of patients receiving surgery for solitary spinal lesions, Sundaresan et al.¹⁰ included 19 patients with Frankel grade B (incomplete spinal cord lesion with preserved sensation only). All improved post operatively, 18 to a functional/mobile Frankel grade (Frankel D or E).

However surgical stabilisation is an excellent treatment for painful spinal metastases in the absence of neurology or nerve root compression.

Tumour type

Characteristics of the primary tumour influence treatment decisions. Radiation is recommended as first line in highly radiosensitive tumours e.g. lymphomas, leukaemia, multiple myeloma and germ cell tumours where there is no significant malalignment. Life expectancy varies with tumour type. Once metastases are detected, the median survival for breast carcinoma is 18-24 months,¹¹ whereas the median survival for metastatic lung disease and melanoma¹² is six months. Surgical treatment is considered and discussed with the patient in the context of their estimated life expectancy.

Extent of metastases

Multiple spinal metastases do not preclude surgery; however, the more extensive the bony involvement, the more difficult the surgery.

General medical condition of the patient

Is the patient in a general condition that safely allows surgery? This is a subjective clinical decision and depends on the surgical procedure proposed. For example, a patient with metastatic lung cancer may not tolerate an anterior vertebral column reconstruction via a thoracotomy or retroperitoneal approach, but may be fit enough for an entirely posterior approach. Deranged LFTs not only raise the suspicion of metastases but also have implications for surgery. Consequent clotting abnormalities increase intra-operative blood loss and low albumin compromises post-operative recovery and wound healing.¹³

Spinal location

The location of the metastatic cord compression determines the approach e.g. in the cervical spine, an anterior approach and column reconstruction is most effective with low morbidity (see box). In the thoracic spine, nerve roots can be sacrificed facilitating decompression of the vertebral bodies and anterior reconstruction via a posterolateral/transpedicular route.⁶

Deformity

When cord compression is a consequence of kyphosis, the only way to achieve decompression is to restore and maintain alignment.⁵ It is not clear from the Patchell trial⁸ whether patients with kyphotic deformity were randomised to treatment or not. However, it is clear that radiotherapy alone will not decompress the cord in this group of patients. Any patients that are treated with radiotherapy alone should be monitored for the development of kyphotic deformity.

Bone quality

The adjacent bone must be of sufficient quality to allow successful instrumentation.

Scoring systems

Various scoring systems have been proposed to aid objective management decisions e.g. those of De Wald,¹⁴ Harrington¹⁵ and Tokuhashi et al.¹⁶ These criteria and scoring systems are useful for cohorts and research but their utility in making decisions for individual patients is questionable. In reality, all of the factors discussed must be considered by a multidisciplinary team and with the patient.

Summary

Despite there being class 1 evidence supporting the role of surgery in the context of spinal metastases, the management decision is often not clear cut. Many different factors, such as

life expectancy, fitness for surgery, symptoms, deformity, site and extent of metastases, must be taken into account and discussed with the patient and amongst the multi-disciplinary team. The accompanying case history and figures illustrate this decision making process. (see Box 1).

Key points

- There have been considerable advances in spinal surgery for metastatic disease
- A randomised controlled trial⁸ has shown clear benefits of surgery
- All patients with symptomatic metastatic spinal disease should be discussed with an appropriately trained spinal surgeon
- Surgery is the only means of decompressing the spinal cord when compression is secondary to deformity

References

1. Klimo P, Kestle JRW, Schmidt MH. *Treatment of metastatic spinal epidural disease: a review of the literature.* Neurosurg Focus 2003;15(5):1-9.
2. Byrne TN. *Spinal Cord Compression from Epidural metastases.* New Eng J Med 1992;327(9):614-9.
3. Schick U, Marquardt G, Lorenz R. *Intradural and extradural spinal metastases.* Neurosurg Rev 2001;24:1-5.
4. Airaksinen O, Brox JJ, Cedraschi C et al. *European guidelines for the management of chronic non-specific low back pain.* European Commission, Research Directorate General. 2004. www.backpaineurope.org
5. Hammerberg KW. *Surgical treatment of metastatic spine disease.* Spine 1992;17(10):1148-53.
6. Bilsky MH, Boland P, Lis E, Raizer JJ, Healey JH. *Single stage posterolateral transpedicle approach for spondylectomy, epidural decompression and circumferential fusion of spinal metastases.* Spine 2000;25(17):2240-50.
7. Ghogawala Z, Mansfield FL, Borges LF. *Spinal radiation before surgical decompression adversely affects outcomes of surgery for symptomatic metastatic spinal cord compression.* Spine 2001;26:818-24.
8. 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 2005;366:643-8.
9. Shenouda EF, Al-Delami E, Germon TJ. *Decompression and reconstruction for severe extradural spinal cord compression.* J Bone Joint Surg [Br]. Orthopaedic Proceedings 2005;87-B:239.
10. Sundaresan N, Rothman A, Manhart K, Kelliher K. *Surgery for Solitary Metastases of the Spine, Rational and Results of Treatment.* Spine 2002;27(16):1802-6.
11. Cardoso F, Di Leo A, Lohrisch C, Bernard C, Ferreira F, Piccart MJ. *Second and subsequent lines of chemotherapy for metastatic breast cancer: what did we learn in the last two decades?* Ann Oncology 2002;13:197-207.
12. Lee SM, Betticher DC, Thatcher N. *Melanoma Chemotherapy.* Br Med Bull; 1995;51(3):609-30.
13. McPhee IB, Williams RP, Swanson CE. *Factors influencing wound healing after surgery for metastatic disease of the spine.* Spine 1998;23:726-32.
14. De Wald RL, Bridwell KH, Prodromos C, Rodts MF. *Reconstructive spinal surgery as palliation for metastatic malignancies of the spine.* Spine 1985;10:21-6.
15. Harrington KD. *Metastatic disease of the spine.* J Bone Joint Surg [Am] 1986;68:1110-15.
16. Tokuhashi Y, Matsuzaki H, Oda H, Oshima M, Ryu J. *A Revised scoring system for preoperative evaluation of metastatic spine tumour prognosis.* Spine 2005;30(19):2186-91.

Abbreviations

FOB	Faecal occult blood
PSA	Prostate specific antigen
CEA	Carcinoembryonic antigen
LFTs	Liver function tests

