ASPECTS OF CURRENT MANAGEMENT

Current concepts in the management of metastatic spinal disease

THE ROLE OF MINIMALLY-INVASIVE APPROACHES


From Rush University Medical Centre, Chicago, USA

The spine is the most frequent location for skeletal metastases which occur in up to 40% of patients with cancer. The most common primary sites are the breast, prostate and lung, with involvement of 39.3%, 23.5%, and 19.9%, respectively and with a slight male predominance. The thoracic spine is affected in up to 70% of cases, followed by the lumbar and cervical areas.

Advances in imaging and instrumentation have allowed improvements in the techniques of excision of the tumour and spinal stabilisation. Despite this, the treatment of spinal metastases remains largely palliative. Surgical decision-making is complex, with clear indications being symptomatic, radioresistant tumours (sarcoma, lung, colon, renal cell), spinal instability, neural compression secondary to retro-pulsed bone, deformity, intractable pain and failure of radiotherapy. Even if the patient satisfies one or more of these indications, the nature and objective of surgery must be determined by the ability of the patient to tolerate the procedure and, more importantly, by their estimated life expectancy.

Minimally-invasive techniques, namely percutaneous cement augmentation, stereotactic radiosurgery and radiofrequency ablation have challenged the conventional management of metastatic spinal disease. These less invasive procedures afford palliation, have a lower morbidity than conventional surgical operations and may alter our decision-making in the future.

In this review we have addressed classification schemes which assist in the management of metastatic spinal disease, the non-operative and operative management available, recent minimally-invasive techniques and the outcome of treatment.

Classification systems

Metastatic lesions of the spine may involve the epidural space, the paravertebral soft tissues and bone. Initially they usually involve the posterior vertebral elements. Lesions may either be solitary or multiple and non-contiguous in nature. Debilitating pain may or may not be associated with metastatic spinal disease and pathological fracture. Without intervention, the natural history of metastatic spinal disease is one of symptomatic progression and the potential for complete and irreversible paralysis. In the past, classification systems for patients with metastatic disease, such as that of Frankel have been largely based on neurological function as it applied to levels of mobility (Table I). However, because

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>No motor or sensory function</td>
</tr>
<tr>
<td>B</td>
<td>Preserved sensation only, no motor function</td>
</tr>
<tr>
<td>C</td>
<td>Non-ambulatory, wheelchair-bound, some motor function</td>
</tr>
<tr>
<td>a</td>
<td>bowel or bladder paralysis</td>
</tr>
<tr>
<td>b</td>
<td>neurogenic bowel or bladder</td>
</tr>
<tr>
<td>c</td>
<td>voluntary normal bowel or bladder function</td>
</tr>
<tr>
<td>D</td>
<td>Ambulatory but with neurological symptoms</td>
</tr>
<tr>
<td>1</td>
<td>Requires walker</td>
</tr>
<tr>
<td>2</td>
<td>Requires cane</td>
</tr>
<tr>
<td>3</td>
<td>Can walk independently</td>
</tr>
<tr>
<td>a</td>
<td>bowel or bladder paralysis</td>
</tr>
<tr>
<td>b</td>
<td>neurogenic bowel or bladder</td>
</tr>
<tr>
<td>c</td>
<td>voluntary, normal bowel or bladder function</td>
</tr>
<tr>
<td>E</td>
<td>Normal neurological function</td>
</tr>
</tbody>
</table>
The patient may be at greater risk of neurological degrada-
ed by an epidural tumour which is not radiosensitive.

Category III lesions represent a grey area regarding medical
intervention irrespective of their Harrington category. Nonetheless, patients with a Harrington classification with neurological deficits and low Frankel grades (Table I) before and after surgical intervention are at increased risk of complications.

The classification of Tokuhashi. The score of Tokuhashi et al. determines the prognosis and life expectancy and is based on six parameters (Table III). This system was applied to 64 patients. Those with a score of ≥ 9 points survived for a mean of 12 months or more, those with a score of ≤ 8 for 12 months or less and those with a score of ≤ 5 for less than three months. The authors recommended that patients with a score of ≥ 9 should undergo an excisional procedure, whereas a palliative operation was suggested for those scoring ≤ 5. No recommendations were made for patients with a score of 6 to 8. While this system was the first to address prognosis as an important factor, two weaknesses were identified. First, no statistical assessment of the point values was assigned for each factor, and, secondly, individual factors were not weighted as to their importance in determining the prognosis. As such, the value of this classification system is in its ability to suggest the need for an excisional or palliative procedure.

The classification of Tomita. A more comprehensive classification by Tomita et al. uses three factors proven to be significant prognostically, namely the grade of malignancy, visceral metastases, and bone metastases (Table IV). Each prognostic factor is given a weighted score which is determined retrospectively. A summed prognosis score of 2 to 3 points suggests the need for a wide or marginal excision for long-term local control, 4 to 5 points indicates the need for a marginal or intralesion excision for medium-term local control, 6 to 7 points justifies palliative surgery for short-term palliation and 8 to 10 points indicates non-operative supportive care. This scoring system was applied prospectively to a series of 61 patients with spinal metastases between 1993 and 1996. Local control was achieved in 43 (83%) of 52 patients who had been treated surgically for more than 80% of the survival period (the life span of the patient). The results suggested that this classification was simple to use, prognostic, and reliably accurate in the management of spinal metastases.

Conventional surgery. Appropriate selection of patients for surgery is critical in determining the functional outcome. The primary aims of surgery are to relieve pain and to prevent or reverse neurological compromise. Table V lists the relative indications for surgery and radiation. The decision to proceed with surgery is complex and requires that several critical factors be considered before a decision can be made.

### Table II. Harrington classification of metastatic disease of the spine

<table>
<thead>
<tr>
<th>Category</th>
<th>Bone/neurological involvement</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No significant neurological involvement</td>
<td>Non-surgical</td>
</tr>
<tr>
<td>II</td>
<td>Involvement of bone without neurological involvement</td>
<td>Non-surgical</td>
</tr>
<tr>
<td>III</td>
<td>Major neurological impairment (sensory or motor) without involvement of bone</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>IV</td>
<td>Vertebral collapse with pain resulting from mechanical causes or instability</td>
<td>Surgical</td>
</tr>
<tr>
<td>V</td>
<td>Vertebral collapse or instability combined with major neurological impairment</td>
<td>Surgical</td>
</tr>
</tbody>
</table>

### Table III. The scoring of Tokuhashi et al.

<table>
<thead>
<tr>
<th>Category</th>
<th>Options (%)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>General condition</td>
<td>Poor (10 to 40)</td>
<td>0</td>
</tr>
<tr>
<td>Number of extraspinal bone metastases</td>
<td>&gt; 3</td>
<td>0</td>
</tr>
<tr>
<td>Number of metastases in the spine</td>
<td>&gt; 3</td>
<td>0</td>
</tr>
<tr>
<td>Metastases to major internal organs</td>
<td>Irremovable</td>
<td>0</td>
</tr>
<tr>
<td>Primary site of cancer</td>
<td>Lung, stomach</td>
<td>0</td>
</tr>
<tr>
<td>Myelopathy</td>
<td>Complete</td>
<td>0</td>
</tr>
<tr>
<td>Prognostic factor</td>
<td>Category</td>
<td>Score</td>
</tr>
<tr>
<td>Grade of malignancy</td>
<td>Slow growth</td>
<td>1</td>
</tr>
<tr>
<td>Visceral metastases</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Bone metastases</td>
<td>Solitary/isolated</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table IV. The surgical strategy of Tomita et al. for spinal metastases

<table>
<thead>
<tr>
<th>Prognostic factor</th>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade of malignancy</td>
<td>Slow growth</td>
<td>1</td>
</tr>
<tr>
<td>Visceral metastases</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Bone metastases</td>
<td>Solitary/isolated</td>
<td>1</td>
</tr>
</tbody>
</table>
Various operative techniques have been suggested for debulking tumour, including anterior, posterior or combined procedures with marginal or wide excision en bloc,\textsuperscript{16,20,22,26,30,35} piecemeal removal,\textsuperscript{36-39} or curettage\textsuperscript{40-43} of the tumour (Fig. 1). However, the selection of a surgical approach should take into account the risks of both mortality and morbidity. In order to help reach an appropriate decision, Fournery and Gokaslan\textsuperscript{44} have proposed a strategy termed ‘MAPS’ (Table VI).

**Morbidity.** In patients with metastatic spinal disease, preoperative radiation, malnutrition and the use of steroids are risk factors for complications.\textsuperscript{35,45,46} Based on a review by Weinstein, McCabe and Cammisa,\textsuperscript{47} who evaluated 2391 cases of spinal surgery over a period of nine years, patients

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**Table V. Relative indications for surgery or radiation as a primary treatment**

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radioresponsive tumour</td>
<td>Retropulsed bone producing neural compression</td>
</tr>
<tr>
<td>Moderately radioresponsive tumour in patients with minimal deficit/limited pain</td>
<td>Spinal deformity producing pain/neural compression</td>
</tr>
<tr>
<td>Isolated epidural neural compression</td>
<td>Spinal instability from bony/ligamentous destruction</td>
</tr>
<tr>
<td>Isolated local pain</td>
<td>Progressive neurological deficit</td>
</tr>
<tr>
<td>Expected survival less than three months</td>
<td>Failure of radiation</td>
</tr>
<tr>
<td>Poor operative candidate</td>
<td>Progressive deficit/pain during radiation</td>
</tr>
<tr>
<td>Complete neurological deficit</td>
<td>Previous radiation with recurrence/progression</td>
</tr>
<tr>
<td>Unknown primary</td>
<td></td>
</tr>
</tbody>
</table>

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A 59-year-old man with metastatic melanoma. a) axial CT scan showing a large soft-tissue mass involving the right pedicle of T7. b) axial MRI showing considerable displacement of the spinal cord. c) a post-operative lateral radiograph showing a posterior pedicular construct from T4 to T12 after a resection of the T7 pedicle.
undergoing fusion with instrumentation and those with metastatic spinal disease had the highest risk of developing wound infection. Ghogawala et al\[35] studied 85 patients with symptomatic compression of the spinal cord and subdivided them into those treated by radiation alone, by radiation followed by surgery and by surgery followed by radiation. They found a rate of major wound complication of 32% for those who had radiation before surgical decompression, which was almost three times higher than the 12% observed in patients who had undergone initial surgery. Of the surgical patients, 75% remained mobile and continent 30 days after treatment, as compared with 50% of those treated by radiation before surgery. In the series of Sundaresan et al\[35] in which 80 patients with metastatic disease had been treated surgically, four had failure of instrumentation, two developed pulmonary emboli and one had neurological deterioration. The most reported wound breakdowns were seen in patients who had undergone earlier irradiation compared with the initial surgery group. Gokaslan et al\[35] found that of 72 patients who had undergone transthoracic vertebrectomy, 21 developed complications ranging from minor atelectasis to pulmonary embolism.

Conventional surgery is successful when life expectancy is high, when surgical resection may offer disease-free survival or when surgery may improve the quality of life by palliation.\[48-52\] Sundaresan et al\[35\] noted that in patients with solitary spinal metastases who underwent resection, the overall median survival after surgery was 30 months, with 18% surviving for five years or more. Survival varied according to the type of tumour, with the best prognosis being seen in patients with breast or kidney tumours. They concluded that solitary sites of spinal metastases represented a biologically favourable subgroup with the potential for long-term survival.\[14,35\]

Delayed surgical intervention is warranted in patients who are medically unstable, have a poor prognosis, or when resection would require a longer recovery period than the life expectancy of the patient. Those patients who survive their disease and defy medical probability can later be treated surgically in order to prevent neurological deterioration and to provide spinal stability.

Timing of surgical intervention. The timing of surgery in the presence of a static or progressive neurological deficit is a complicated issue. The natural history of compression of the spinal cord depends upon its aetiology and duration. Approximately 5% to 10% of patients with spinal metastases develop epidural spinal-cord compression, of whom only 10% to 20% become symptomatic.\[6,15,53\] Decompression is effective in terms of neurological recovery of an incomplete spinal-cord deficit if the onset of neurological decline is gradual. However, rapid neurological loss responds less well to surgical intervention unless it is promptly undertaken,\[54-57\] although the precise timing of surgery has never been clarified. Most clinicians support intervention for a static neurological deficit when the patient is medically stable and the operating team and resources are available. A decision to proceed immediately should be determined on a case-by-case basis, reflecting the potential morbidity to the patient in the presence of a progressive neurological deterioration.

Recurrent metastatic disease. Various reports have stressed the risk of recurrence of the tumour after operative intervention, the risk increasing if wide or marginal excision is not obtained\[22,30\] and if irradiation precedes surgery.\[35,58\] Nonetheless, revision surgery in metastatic disease has a much higher rate of associated complications than in non-tumour patients because of the presence of devitalised tissues, chemotherapy and radiation exposure, and the poor nutritional status of the patient. The choice of operation should always take into account the potential for longer-than-expected survival and early-onset recurrence and growth of the tumour. In patients with prolonged survival, surgical intervention should address symptomatic non-healed fusions, extend a fusion, or replace failed or loosened implants. The choice of grafting is important since methylmethacrylate has a finite life span and will fail if a patient survives for longer than is expected. In addition, if a metal implant is used anteriorly, especially in close proximity to the great vessels, the potential for its migration could compromise the vessels, causing impingement on the vessels is high if local recurrence occurs and destroys the site of anchorage of the implant.

Radiation therapy

Conventional spinal radiotherapy. Radiotherapy is the initial treatment for most patients with metastases to a vertebral body.\[59\] In patients with a poor prognosis it may be the only treatment used. Radiation alone is appropriate therapy for patients with minimal or no neurological findings, tumours known to be radioresponsive, when there is no evidence of osseous instability and no symptomatic neural compression by bone. Radiotherapy has been found to control pain, decrease the size of the tumour and inhibit its growth.\[60\]

The dose of radiation used depends upon the type of tumour and the length of treatment. Conventional external-beam radiotherapy typically delivers a total dose of 2500 to 4000 cGy of radiation over eight to 20 daily fractions. Generous margins are used to compensate for the movements of both the internal organs and the patient dur-
ing treatment. Consequently, a substantial amount of normal tissue, including the spinal cord, is exposed to radiation. However, there is variation between countries and centres as to the method of delivery of radiotherapy, primarily between the use of single- and multi-fraction treatments. According to Sze et al, there is no difference between the use of single- and multi-fraction radiotherapy in the control of bone pain from metastases, although a higher incidence of pathological fractures and treatment sessions was noted in single-fraction radiotherapy.

Although the role of radiotherapy in metastatic spinal disease has been addressed to some extent, its efficacy in comparison with surgical intervention remains questionable. In 1980, a randomised, controlled trial by Young, Post and King compared patients with spinal epidural metastases who underwent surgery followed by radiotherapy, with those who had radiotherapy alone. The authors found no significant difference between the two groups in terms of mobility, sphincter control, and relief from pain. However, since the study sample was small and surgical intervention was limited to laminectomy, they stressed that their findings were inconclusive. Since then, randomised, controlled trials addressing the efficacy of radiotherapy in comparison with surgery for metastatic spinal disease have not been carried out, with the exception of a recent trial by Patchell et al. They compared radical resection followed by radiotherapy, with radiotherapy alone for the treatment of metastatic compression of the spinal cord and concluded that surgery allowed patients to regain mobility and to walk for longer periods, as compared with those who had radiation alone. Furthermore, surgery allowed continence for a significantly longer period and maintenance of the Frankel function and American Spinal Injury Association scores. In addition, based upon a systematic review of the literature on the evaluation of management options in metastatic spinal disease, it has been recommended that radiotherapy should primarily be considered for individuals with complete paraplegia or paralysis, or those who had a radiosensitive tumour.

**Stereotactic radiosurgery and intensity-modulated radiotherapy.** Recent developments in non-conventional radiotherapy, stereotactic radiosurgery and intensity-modulated radiotherapy, have allowed for focused beam radiation. Stereotactic radiosurgery involves the principle of stereotactic localisation in order to achieve accurate targeting. In intensity-modulated radiotherapy, multiple beams are used, but the intensity of each individual beam can be modified, thereby minimising radiation exposure to surrounding structures. Treatment is delivered in one or two sessions with total doses ranging from 800 to 1800 cGy. Early versions of spinal radiosurgery, using a linear accelerator, required multiple incisions of 1 cm to 2 cm to fix a frame to the spinous processes. Current image-guided stereotactic radiosurgery systems, such as the Novalis system (BrainLAB, Munich, Germany) and CyberKnife (Accuracy Inc, Sunnyvale, California), differ from earlier frame-based systems in four ways: 1) referencing is based on the internal skeletal anatomy, implanted fiducials (radiographic markers), or infrared surface markers; 2) near real-time images are acquired to correct for movement; 3) fixed isocentres are not required, allowing irregular dose shapes; and 4) intensity modulation increases the conformality of radiation to the tumour, thereby minimising the dose to normal tissue.

In a study by Bilsky et al, 16 paraspinal tumours were treated by intensity-modulated radiotherapy which was administered using a linear accelerator mounted with a multilead collimator. There were 11 patients treated for symptomatic, post-surgical recurrence, one for post-irradiation metastatic pancreatic gastrinoma, and four had primary tumours with positive histological margins. A total of 12 patients had pain, functional radiculopathy or both. At a follow-up of one year, 12 showed either no internal growth or a reduction in the size of the tumour. Two patients, one with a thoracic chondrosarcoma and one with a chordoma, had progression. Pain improved in a total of 11 patients, while four had significant improvement in their radiculopathy and/or plexopathy.

Yenice et al determined the clinical feasibility of CT-guided intensity-modulated radiosurgery for patients with spinal metastases. Ten patients were treated by fractionated radiotherapy followed by a single-dose radiosurgery. The accuracy for the isocentre was measured by CT reconstruction. Most patients had prompt relief from pain and partial recovery of motor function with treatment, within two to four weeks. The maximum dose of radiation to the spinal cord was 50% of that prescribed, with no detectable toxicity.

Yenice et al developed and tested a stereotactic body frame for the rigid immobilisation of patients with paraspinal tumours. Patients with thoracic and lumbar lesions were immobilised and positioned for 33 treatment fractions using CT imaging. The authors noted that the frame provided immobilisation for paraspinal targets with an accuracy of set-up better than 2 mm (1 SD) and reduced uncorrected system errors and irradiation to the spinal cord.

The largest series to date on the use of frameless, stereotactic radiosurgery was carried out by Gerszten et al using the CyberKnife (Fig. 2). In 115 consecutive patients 125 spinal lesions (17 benign; 108 metastatic) were treated by intensity-modulated radiotherapy which was administered using a linear accelerator mounted with a multilead collimator. There were 11 patients treated for symptomatic, post-surgical recurrence, one for post-irradiation metastatic pancreatic gastrinoma, and four had primary tumours with positive histological margins. A total of 12 patients had pain, functional radiculopathy or both. At a follow-up of one year, 12 showed either no internal growth or a reduction in the size of the tumour. Two patients, one with a thoracic chondrosarcoma and one with a chordoma, had progression. Pain improved in a total of 11 patients, while four had significant improvement in their radiculopathy and/or plexopathy.

Stereotactic radiosurgery may provide focused radiotherapy and thereby limit the side-effects observed with conventional beam radiation. However, data on these treatments are limited to small case series with a short period of
follow-up. Outcome measures, including neurological function, functional improvement, and evaluation of objective pain, such as by narcotic requirements, are rarely discussed. At present, the application of spinal stereotactic radiosurgery or intensity-modulated radiotherapy is usually limited to patients who are either poor surgical candidates with recurrent disease, are medically inoperable or as an adjunct to surgery. Although radiosurgical ablation of spinal lesions offers a considerable potential benefit, for the moment it should be considered as experimental therapy.

**Radiofrequency ablation.** Reports on radiofrequency ablation of vertebral body metastases are rare and are limited to case reports. Dupuy et al\(^7\) described a 54-year-old woman with a focal lesion in the vertebral body of L2, who was successfully treated by radiofrequency ablation. However, the largest series to date was reported by Gronemeyer, Schirp and Gevargez.\(^7\) Ten patients with inoperable spinal metastases were treated using a 50W radiofrequency generator connected to an expandable electrode catheter by applying temperatures of 50°C to 120°C for eight to 12 minutes (RIA Medical System, Mountain View, California). Vertebroplasty was performed as an adjunct in four patients. At follow-up, nine of ten patients reported reduced pain, as judged by a visual analogue scale, with a mean reduction of pain of 74.4%. Neurological function was preserved in nine patients and improved in one. Local recurrence of tumour was not seen on MRI. Besides the obvious limitation of this study because of its small sample size, an assessment of neurological function was not given by the authors.

**Vertebroplasty/kyphoplasty.** Since its introduction as a treatment for haemangiomas of the vertebral body, cement augmentation is now used for compression fractures from osteoporosis, multiple myeloma, and metastatic spinal disease.\(^7\)-\(^9\) Not surprisingly, the rate of complications of percutaneous vertebroplasty in patients with metastatic disease is higher than that in osteoporotic patients.\(^7\) In patients with tumours, there are likely to be osteolytic areas with destruction of the bone cortex, thereby increasing the risk of symptomatic leakage of polymethylmethacrylate into the spinal canal and neural foramina (Fig. 3).\(^7\)

Shimony et al\(^7\) assessed the efficacy of percutaneous vertebroplasty for metastatic spine disease. They retrospectively stratified 50 patients into three groups with no epidural involvement, mild epidural involvement without contact of the spinal cord or nerve roots and moderate involvement and contact with the spinal cord or nerve roots. They found no significant difference between the groups in the outcome for pain or mobility. There was an improvement in pain, in 41 of 50 patients while six
reported no change and three had increased pain. Complications included an acute increase in pain or new areas of pain in seven patients. None required surgery, four being treated by nerve-root block, two by central epidural injections and one with intravenous steroids overnight.

Alvarez et al. also evaluated the efficacy of vertebroplasty in the treatment of vertebral tumours in 21 patients with special reference to functional outcome. Thirteen patients could not walk. Treatment included percutaneous vertebroplasty in all patients, radiotherapy in 15 and surgery in three. Pre-procedural pain, measured by a visual analogue scale, was 9.1, decreasing to 3.2 after the procedure and 2.8 by the last follow-up visit. Ten of 13 patients (77%) recovered their walking capacity and neurological status improved in three of five. The confounding variable in this study was that the sample group included patients treated by several methods other than percutaneous augmentation of cement, such as radiation and surgical decompression. However, Jang and Lee noted in a series of patients with osteolytic metastatic spinal tumours, who had undergone percutaneous vertebroplasty combined with radiotherapy, that there was relief from pain in 48% on the third post-operative day, with neither neurological deterioration nor vertebral collapse evident at the last follow-up. Nevertheless, they also noted minor extravertebral body leakage of cement in 72.2% of the levels, all of which were asymptomatic.

The largest North American series reporting augmentation of cement for metastatic spinal disease is that by Fourney et al. A total of 97 procedures (65 vertebroplasty and 32 kyphoplasty) was performed in 56 patients. Patients noted marked or complete relief from pain after 49 procedures (84%) and no change after five (9%). Asymptomatic leakage of cement occurred during vertebroplasty at six
of 65 levels (9.2%) while no extravasation was seen during kyphoplasty. Important findings included considerable, lasting relief from pain with a corresponding decrease in the narcotic requirements in the patients treated. In a prospective study by Gerszten et al,32 who evaluated 26 patients with pathological compression metastatic spinal fractures, the combination of kyphoplasty followed by radiosurgery resulted in an improvement in back pain in 92% of the patients with no radiation-induced injury to the spinal cord at the final follow-up. Such a combined therapeutic approach avoids the morbidity associated with the more open surgical procedures, while stabilising the spine, providing relief from pain, and facilitating local control of the tumour by the delivery of a single-fraction tumouricidal dose of radiation.

The role of vertebroplasty and kyphoplasty in the management of metastatic spinal disease is evolving. Although performed for other benign conditions such as osteoporosis, percutaneous cement augmentation has only recently been introduced for the management of oncological patients. Only very early results are available and the sample sizes are small. However, these techniques appear to be safe and effective in well-selected patients with refractory spinal pain from metastatic disease.

**Endoscopic spinal surgery.** This type of surgery has gained tremendous momentum, mainly in the treatment of disc herniation and fractures. It is believed that the use of endoscopic instrumentation in minimal-access surgery enhances visualisation of the operative site for the entire theatre team and minimises tissue trauma, blood loss, pain, post-operative drug use and the length of hospital stay in comparison with more open, conventional procedures. However, its role in the treatment of metastatic spinal disease is limited. Despite this, several case series have noted successful vertebrectomy, reconstruction and stabilisation in patients with metastatic spinal disease who have undergone surgical intervention using endoscopic techniques.83–90 However, endoscopic procedures are not without complication and further studies are needed to gauge the efficacy of endoscopic procedures in comparison with open, conventional procedures for the treatment of metastatic spinal disease.

**References**


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