



Vertebrectomy and anterior reconstruction for the treatment of spinal metastases

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The purpose of this study was to retrospectively analyse the outcome of modular vertebral body replacement in conjunction with vertebrectomy in cancer patients with skeletal metastases.

Between 1996 and 2000, we performed vertebrectomy with subsequent implantation of a modular vertebral body replacement in 24 patients with skeletal metastases of the spine. The findings were analysed retrospectively.

The mean postoperative survival period for all patients was 15.6 months. Improvement of preoperative back pain was achieved in 85%. Remission of initial neurological symptoms based on the Frankel classification was achieved in 57.1% of the patients. Implant dislocations were not observed during follow-up.

Vertebrectomy for vertebral metastasis is indicated in selected patients. Type of underlying malignancy, metastatic spread and adjuvant treatment options are an important basis for the indication. In anterior defect reconstructions, modular implants can directly restore stability while reducing tumour-related symptoms.

Keywords : spine ; metastases ; vertebrectomy ; replacement.

INTRODUCTION

The objectives of surgical interventions for malignant lesions of the spine include stabilisation and improvement of tumour-related symptoms. Given these objectives, the extent of the surgical

procedure is determined by the prognosis associated with the type of underlying malignancy. Skeletal metastases make up the largest percentage of spinal tumours. At the time of tumour staging, it is not rare to find multifocal lesions. Treatment can only be palliative. The primary aim is to prevent neurological complications and local instability resulting from extensive tumour growth. When such palliative situations are encountered, one should strive for limited surgical interventions such as posterior instrumentation with spinal canal decompression. In such a context, adjuvant treatments should be discussed as a possible supplement to surgical management.

When considering surgery on spinal metastases, meticulous differential diagnosis should precede more extensive surgical treatments such as vertebrectomy. In addition to preoperative tumour staging, it is necessary to ascertain which treatment

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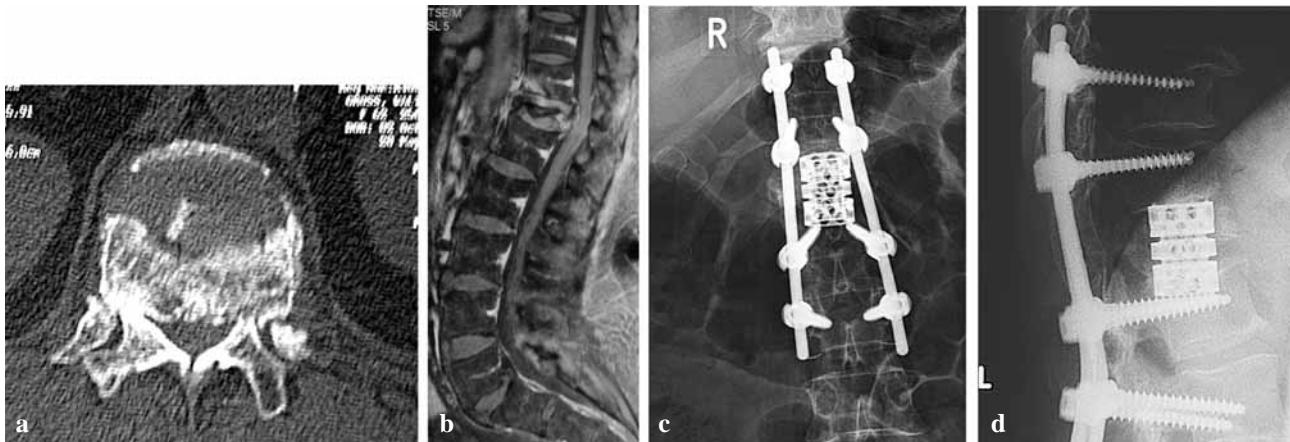


Fig. 1. — a) + b) CT scan + MRI show a T12 collapse secondary to metastatic adenocarcinoma ; c) + d) Postoperative anteroposterior and lateral radiographs showing dorsal fixateur interne and anterior reconstruction of T12 using a modular device.

goals can be achieved by surgical intervention. The concept of surgical resection margins according to Enneking (7) has only limited applicability in spinal surgery. Even with total vertebrectomy, at best only a marginal resection is possible due to the anatomical situation. Considering this fact, advanced discussions should be held as to which prerequisites result in the indication for vertebrectomy when skeletal vertebral metastases are present. In this context the main focus of this study was to retrospectively analyse the outcome of modular vertebral body replacements in conjunction with vertebrectomy in cancer patients with skeletal metastases.

PATIENTS AND METHODS

In 24 patients (14 female and 10 male) with skeletal metastases of the spine, vertebrectomy with subsequent implantation of a vertebral body replacement was performed between 1996 and 2000. All patients in this series underwent additional posterior instrumentation in the form of internal fixation with spinal canal decompression (figs 1 a-d, 2 a-c). Vertebral body replacement was performed in both the thoracic and lumbar segments of the spine (fig 3). Preoperative tumour staging was performed in all patients. Treatment strategy was guided by the type of primary tumour, the extent of metastases present and the conditions affecting stability.

A retrospective evaluation of the patients was carried out between October 2001 and January 2002. The analysis covered any existing medical records and imaging results (conventional radiographs, computed tomography and MRI scans). Postoperatively surviving patients were invited back for a clinical and radiological follow-up. The postoperative performance status was assessed using the Karnofsky score. The Karnofsky score includes three areas with individually weighted items to determine whether the patient was able to perform normal activities independently or required assistance. Performance was measured in percent, with a score of 100% representing complete independence.

The implant

Vertebral body reconstruction was performed using the VBR™ vertebral body replacement device manufactured by Ulrich Medizintechnik, Ulm, Germany. This modular implant system consists of a proximal and a distal ring component, both of which are connected together by a central screw thread (fig 4 a-b). The modularity of the components allows for height adjustment, which means that the implant can be used to replace one to multiple vertebral bodies. After vertebral body resection, the implant cylinder can be positioned intraoperatively and then distracted *in situ*. Throughout the course of this procedure, it is possible to bridge defects while achieving defect expansion at the same time. Tooth-like adaptors at both the proximal and distal ring components

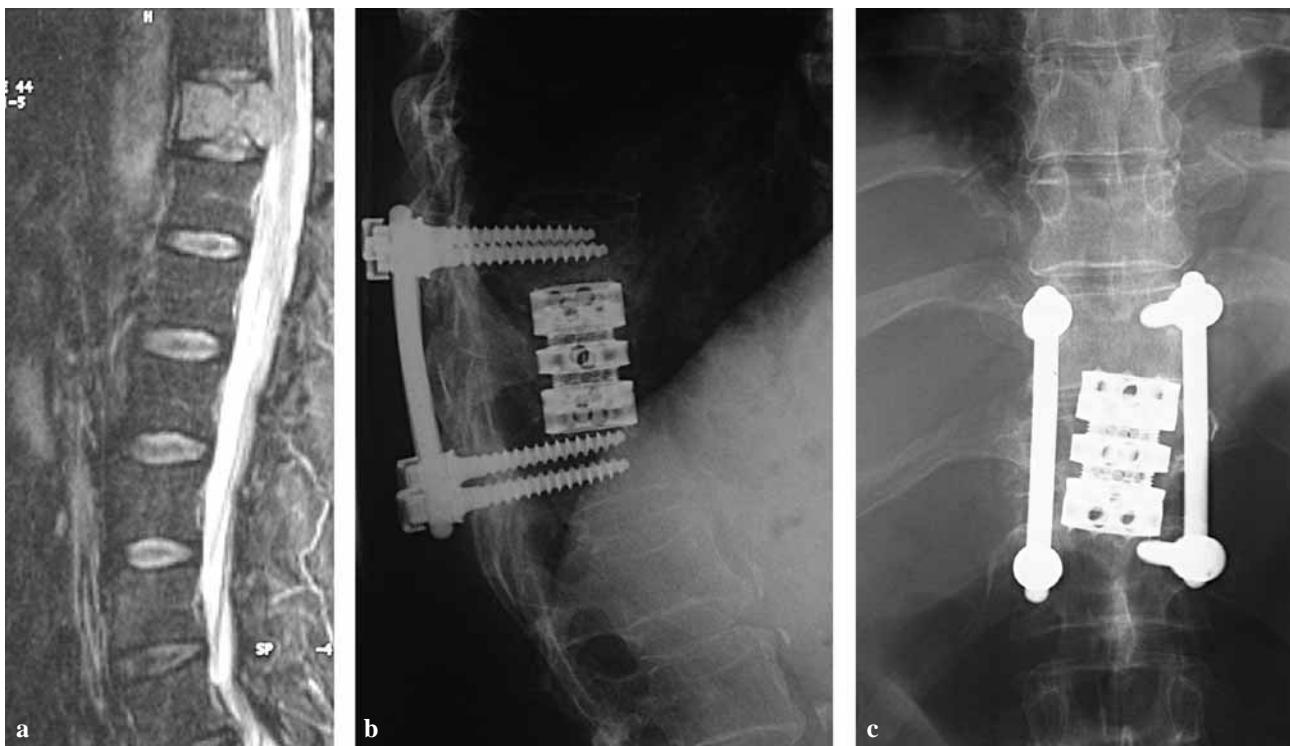


Fig. 2. — a) Sagittal MRI image shows a metastatic lesion at T11 with spinal chord compression ; b) + c) Dorsal instrumentation and decompression in combination with vertebral body replacement.

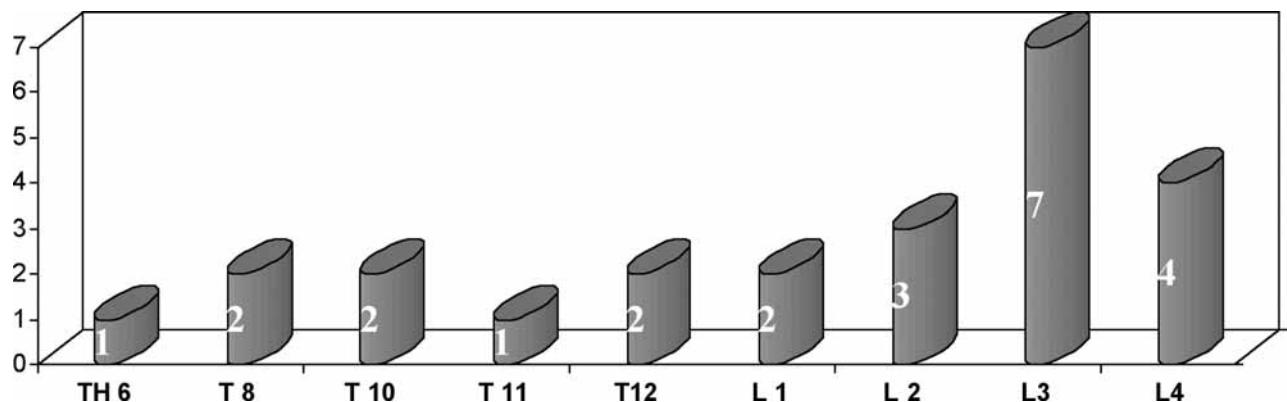


Fig. 3. — Number of treated vertebrae (n = 24)

facilitate secure implant anchorage and provide the contact required between the implant and the adjacent vertebral body end plates. This kind of implant anchorage ensures implant tension ; the cylinder can be distracted *in situ* and stability of the affected spinal segment can be restored. The implant is available in various sizes to fit the defect remaining after tumour resection.

RESULTS

The data and radiological results of a total population of 24 patients with metastasis to the spine from various tumours were analysed retrospectively. Mean patient age at the time of surgery was

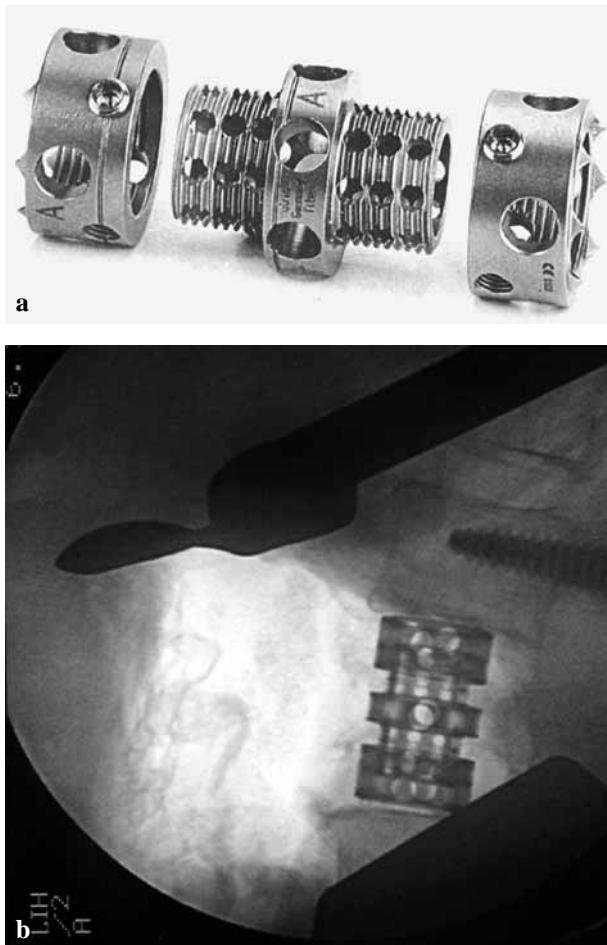


Fig. 4. — a) VBR™ vertebral body replacement ; b) Intra-operative radiograph after implant positioning.

57.8 years (34-76 years); a total of 19 patients died during the follow-up period. Irrespective of the primary tumour type, mean postoperative overall survival was 15.6 months (12.9 months for patients who died during follow-up and 25.8 months for patients who survived at follow-up) (fig 5). In all patients, the indication for vertebral body replacement was based on the extent of tumoral spread while taking into account the risk of instability and any adjuvant treatment options. With regard to pre-operative clinical symptoms, 20 patients reported local back pain. Preoperative neurological signs such as reduced sensitivity with a radicular distri-

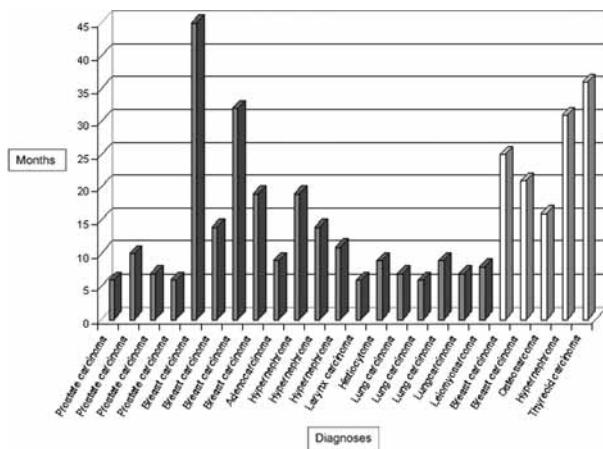


Fig. 5. — Postoperative survival period :
█ deceased patients at the time of last re-examination
□ surviving patients at the time of last re-examination.

Tab. 1. — Frankel Classification

| Frankel Grade | Characteristic |
|---------------|---|
| Frankel A | Complete lesion (paraplegia) |
| Frankel B | Only sensory function |
| Frankel C | Motor function is present, but of no practical use (nonambulatory) |
| Frankel D | Motor function is present, sufficient to allow walking (ambulatory) |
| Frankel E | No neurologic signs or symptoms |

bution, and progressive paresis of the lower extremities were present in 7 patients (paresis of hip flexor muscles : n = 1, quadriceps paresis : n = 4, paresis of the foot extensor muscles : n = 2). Based on the Frankel classification (table I), these patients were classified as Frankel category D. The surgical intervention succeeded in halting progression of the clinical symptoms in 100% of the patients with 85% of the patients reporting regression of their local pain symptoms. During the post-operative monitoring period 57.1% of the patients reported an improvement of initial neurological findings (Frankel E).

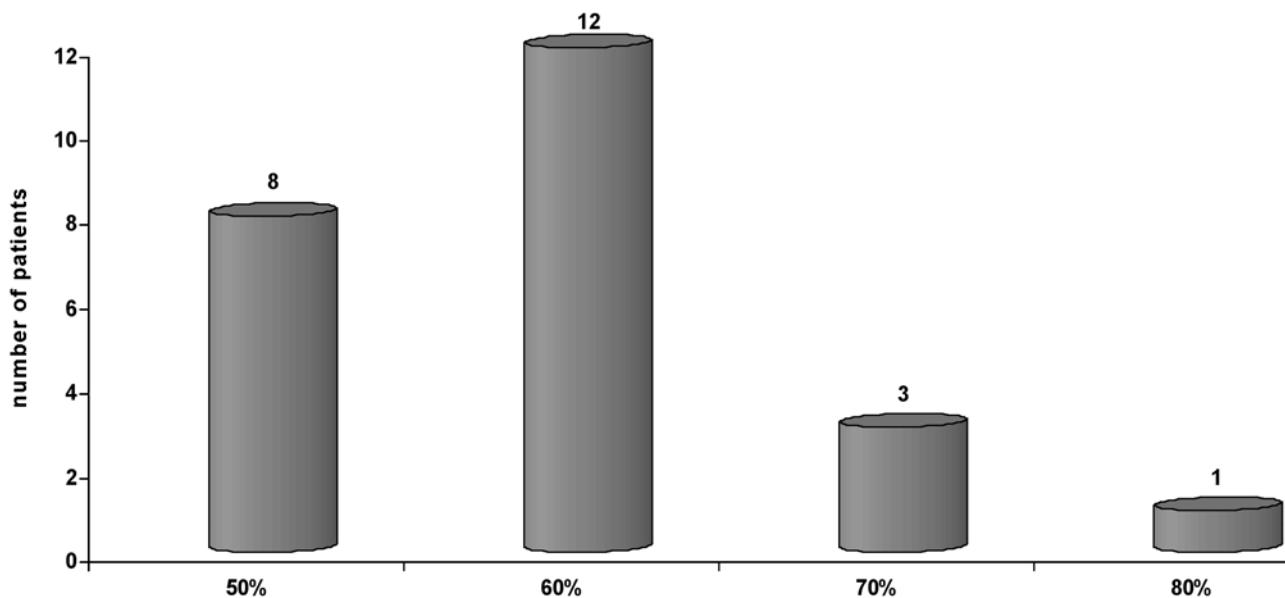


Fig. 6. — Postoperative Karnofsky scoring (n = 24)

The clinical symptoms existing immediately after surgery were reported to be local pain, although this was primarily attributed to the surgical intervention.

Further intercurrent symptoms such as fever, pleural effusions or complications resulting from postoperative adjuvant therapy were reported in isolated cases only. In all patients, postoperative radiological follow-up showed that the implants were seated properly, sagittal spinal profiles were restored and no tendency to dislocation was observed. Based on existing medical records as well as last re-examination results of surviving patients, Karnofsky scoring was possible on all cases. Assessment of their ability to perform routine tasks independently showed a general performance status between 50% and 80% (fig 6) at follow-up, which allowed them to take care of themselves with little or no support.

DISCUSSION

The surgical strategies for managing tumorous changes of the spine are dictated by various criteria. Preoperative tumour staging is the starting

point for the choice of the surgical procedure. In this context, the following aspects should be addressed :

- Type and spread of the underlying tumour,
- Extent of any existing metastatic spread,
- Preoperative physical status of the affected patients.

Given these aspects, the surgical intervention is closely linked to the prognosis for the underlying tumour type. The indication for more aggressive surgical interventions for cancer management should be made after weighing the risks and benefits of these options. In addition to preoperative tumour staging, an assessment should be made as to whether the treatment goals are surgically achievable while taking the expected survival time into consideration. In spinal surgery with resection margins according to Enneking (7), a vertebrectomy can achieve at best marginal resection. This means that, even in the most favourable case, microscopic pieces of the tumour may remain in the surgical field. Given this fact, the surgical procedure should be discussed in relation to the availability of adjuvant therapeutic options which might offer a

logical supplement to surgery and thus improve postoperative survival.

Skeletal metastases represent the largest group in patients with malignant bone tumours. Up to 70% of all malignant bone tumours are metastases (23). The incidence varies depending on the primary tumour and disease duration. In 80% of all cases, the skeletal metastasis derives from breast, prostate, lung or kidney cancers (9). Prostate cancer is the most frequent malignancy producing osteoblastic metastases. The overwhelming majority of osteolytic metastases are found in patients with hypernephroma, lung, breast, thyroid and gastrointestinal cancers.

Therapeutic approaches in surgery for metastasis of the spine must be determined by the extent of existing metastatic spread and the expected postoperative survival time. In terms of surgical strategies, the literature offers varying views depending on the clinical baseline status. In palliative situations where the patients are suffering from progressive pain and have pre-existing neurological symptoms, posterior instrumentation with supplemental decompression is overwhelmingly favoured as the method of choice (1, 5, 6, 20). In their prospective evaluation, Wai *et al* (20) found that appropriate surgical management can positively affect the individual's quality of life by reducing the postoperative pain level. Decompression of the affected spinal segment performed alone without supplemental instrumentation should only be carried out in exceptional cases, owing to the loss of stability to be anticipated (6).

Various options have been presented in the literature with regard to anterior surgical procedures. Weigel *et al* (21) and Buchelt *et al* (4) reported their positive experience with anterior spinal cord decompression in terms of improved postoperative results. According to Capelutto (5), however, the indication for an anterior intervention should be made with caution, given the risks of surgery and the long postoperative recovery period. Olerud and Jonsson (15) took into account the expected survival period when determining the surgical management strategy to be employed. They recommended that secondary reconstruction of the anterior column should only be considered in patients with an

expected survival exceeding 6-12 months. When solitary metastases are present, many reports in the literature describe anterior tumour removal by extensive excision or vertebrectomy (6, 12, 19).

Various types of vertebral body replacement devices (2, 8, 10, 12) have been used for anterior reconstruction, combined with autologous and/or allogeneic bone grafting (13, 14, 17). Satisfactory results with both auto- and allografts and vertebral body replacement devices have been reported in the literature. When anterior reconstruction is considered, the primary aim of surgical management is to achieve immediate stability while avoiding loss of correction. When bone grafts are used and particularly in the case of larger anterior defects, additional posterior instrumentation is necessary to guarantee sufficient stability while eliminating any segmental overloading of the bone graft (3). On the whole, complication rates tend to be low when autografts and/or allografts are used (3, 11, 14). One aspect should be critically noted, however: primary stability is initially achieved by press-fit bone grafting, while bony ingrowths take place later. In this context, consideration must be given to the fact that after tumour surgery of the spine, subsequent changes such as local tumour recurrences or even bone necrosis secondary to adjuvant radiation can influence the stability of the incorporated bone graft.

For these reasons, the use of implants for vertebral body replacement is becoming increasingly popular. Modular implants that allow intraoperative adaptation to the defect are of particular interest since they can provide immediate primary stability by optimally bridging the defects (2, 8, 10). In these situations, it is also possible to bridge multiple vertebral body levels.

Depending on the features and properties of the implant as well as the tumour localisation, modular implant systems allow strictly anterior instrumentation. Postoperative implant dislocations have been reported in a few isolated cases (10). The data in the literature mainly focus on direct restoration of segmental stability along with a parallel improvement of preoperative tumour-related symptoms such as pain and the development of neurological sequelae (8, 10, 16, 18, 22). In this context our own study results were comparable to the literature.

With the aim of optimizing the postoperative results, adjuvant treatment options should be discussed irrespective of the surgical procedure but taking into account the primary tumour as well as the general health status of each patient. As many as 79.1% (n = 19) of the patients in the sample we evaluated had died during follow-up. Considering the mean postoperative survival of less than one year with a broad range between 7 and 45 months in our sample, one should discuss when and in which instances vertebrectomy yields greater benefits for the patients than a strictly palliative posterior instrumentation with decompression. In the retrospective evaluation we conducted, our patients with thyroid cancer and breast cancer exhibited the longest postoperative survival times.

Due to the small sample size, in our opinion the indication for vertebrectomy in these tumour entities should also be adapted to each individual's baseline status. In line with the evidence on spinal metastasis surgery reported in literature, we believe a vertebrectomy should primarily be carried out in the case of solitary metastases, when the primary tumour can be expected to show good response to adjuvant radiation and/or chemotherapy. When indicated in this context and performed in conjunction with the available staging-dependent adjuvant treatment options, vertebrectomy allows for extensive tumour excision in the case of localized spread and can positively influence postoperative survival. Depending on the nature of the anterior defects to be treated, modular implants for vertebral body replacement may provide direct restoration of stability.

CONCLUSION

Current surgical management of tumorous lesions of the spine, of which skeletal metastases make up the largest percentage, not only aims at achieving stabilisation, but also at improving tumour-related symptoms. The prognosis of the underlying tumour type can also be a determining factor for the choice of a surgical procedure. In palliative situations, the preferred method is posterior instrumentation in combination with spinal canal decompression. More extensive surgical interven-

tions such as vertebrectomy may be indicated in selected patients. The type of underlying primary tumour, the extent of metastases as well as adjuvant treatment options are all important factors in the equation. Our retrospective analysis demonstrated that vertebral body replacement with modular components in conjunction with vertebrectomy improve outcome in selected cancer patients with skeletal metastases. In anterior defects, modular vertebral body replacements also guarantee immediate restoration of stability while reducing tumour-related clinical symptoms.

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