Open kyphoplasty for management of metastatic and severe osteoporotic spinal fracture

Technical note

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Object. Elderly patients in poor general health frequently suffer vertebral body (VB) fractures due to osteoporosis or vertebral metastatic lesions. Kyphoplasty and vertebroplasty have become the standard treatment for these types of fractures. In certain conditions that cause local kyphosis, such as spinal cord compression due to a metastatic epidural tumor or the shortening of the spinal canal secondary to vertebral compression, the surgical treatment should provide decompression and stabilization during a short intervention. In this study the authors evaluated a surgical technique that frequently combines a same-session surgical decompression, such as a laminectomy, and posterior instrumentation-assisted stabilization during the same open intervention in which the VB is stabilized by kyphoplasty.

Methods. During an 18-month period, the authors treated 18 patients with VB fractures according to this protocol: 14 patients with vertebral metastatic lesions and four with osteoporosis. The patients’ mean age was 60 years. All suffered severe pain preoperatively (mean visual analog scale [VAS] score of 7). Fourteen of the 18 patients suffered a neurological deficit. Twenty-three vertebral levels were treated; in 15 patients it was necessary to place posterior instrumentation. The mean duration of the intervention was 90 minutes.

Pain in all patients improved 3 days after the intervention, and the mean VAS score decreased to 2. Patients with a neurological dysfunction improved. The mean quantity of injected cement for the kyphoplasty procedure was 7 ml. The mean duration of hospitalization was 7 days. Neuroimaging revealed cement leaks in two cases: one into the disc interspace and one anteriorly into the fractured part of the vertebra. After the intervention, most patients with metastatic lesions underwent radiotherapy. No procedure-related complications occurred.

Conclusions. This procedure allows decompression of the spinal cord, consolidation of the VB and thus a stabilization of the vertebral column, and may provide an alternative treatment to invasive VB excision in patients in poor general health.

Key Words • kyphoplasty • spinal cord compression • metastasis • spinal surgery

Bone metastases and especially vertebral metastatic lesions occur in approximately 30% of cancer patients and adversely influence the patient’s general condition. Examination of autopsy reports has indicated that the two types of cancer most frequently associated with vertebral metastatic disease are prostate (90%) and breast (70%) cancer. The younger the patient is at the time that cancer develops, the higher the risk that vertebral metastatic lesions will occur.

The management of vertebral metastatic disease consists of a combination of treatments such as chemotherapy, radiotherapy, surgery, vertebroplasty, and kyphoplasty. The selection of a treatment option is predicated on the dominant symptom, which can be pain or neurological dysfunction. Standard treatment for VB fractures consists of surgery and radiotherapy; the objectives have always been to decompress and to stabilize the spine. The treatment selection, however, will also be influenced by the patient’s general condition. For pain management a combination of radiotherapy and vertebroplasty or kyphoplasty has been indicated. Percutaneous treatment, however, is contraindicated in cases of spinal cord compression with nerve root involvement and a loss of vertebral height greater than 75%.

Osteoporotic vertebral compression fractures may also

Abbreviations used in this paper: CT = computed tomography; LOS = length of stay; PMMA = polymethylmethacrylate; VAS = visual analog scale; VB = vertebral body.
be complicated by the compression of neural structures, thus requiring decompression and stabilization. Although vertebroplasty and balloon-assisted kyphoplasty have become standard treatments for VB fractures, the percutaneous approach may be dangerous when medullary compression is present.

In this study we describe a technique that allows spinal cord decompression and vertebral stabilization during one session. The procedure consists of the combined laminectomy and balloon-assisted kyphoplasty, and, if necessary, osteosynthesis.

**Clinical Material and Methods**

**Patient Population**

Between April 2004 and September 2005 18 patients underwent an open kyphoplasty procedure. Four patients (three men and one woman, mean age 73 years, range 65–80 years) suffered osteoporotic fractures, and 14 patients (six men and eight women, mean age 56 years, range 31–69 years) had metastatic fractures with associated spinal cord compression. These conditions form a contraindication to percutaneous balloon kyphoplasty.

All patients used opioid analgesics to control their pain (mean VAS Score 7). Spinal cord compression resulted in a neurological deficit in 14 of the 18 patients. One patient suffered from an isolated radicular compression.

In these 18 patients 23 vertebral levels were treated: three one patient; two in three patients; and one in 14 patients. In one patient with medullary compression due to metastases from kidney cancer, the vertebral tumor was embolized preoperatively.

**Operative Procedure**

All patients were treated after the induction of general anesthesia; they were placed in the decubitus ventral position, allowing a posterior approach to the vertebral column. A laminectomy was first performed to achieve decompression of the spinal cord and reduce the epidural tumor (Figs. 1 and 2). Osteosynthesis (a short-length spinal fixation) was then performed in 15 patients, each with a vertebral fracture causing significant kyphosis; pedicle screws were placed at the levels above and below the targeted vertebra (Fig. 3). This osteosynthesis allowed the fracture to be reduced by distraction and lordosis. Kyphoplasty was then performed via a transpedicular approach. The two pedicles were canaled under fluoroscopic control. The orientation was controlled through the opening of the fracture and by direct palpation of the pedicles. In one case a unilateral canalization was used at the T-4 level.

For vertebrae inferior to the T-8 level, we used 20-cm³ balloons, and for the levels above T-8 we used 15-cm³ balloons. The mean duration of the surgical intervention was 90 minutes (range 60–120 minutes). None of the patients required a blood transfusion during the intervention.

**Results**

Patient details, history, and treatment outcome are summarized in Table 1. After surgery, the mean VAS pain intensity score decreased from 7 to 2. Two patients ceased to require any analgesic treatment. All patients with preoperative neurological dysfunction experienced an improvement. In most cases improvement was due to the resolution of the metastatic epidural spinal cord compression. Although an imaging-documented anterior compression may persist in some patients, the neurological improvement observed was certainly the result of reducing the local kyphotic deformity and the cord decompression. Postoperative sagittal and coronal CT reconstructions were made of the treated vertebrae and also of the osteosynthesis material.

Control imaging revealed two cement leaks: one into the disc space and one anteriorly into the fractured part of the vertebra without passage to the anterior vein. No posterior wall fracture was noted and no cement leaked into the spinal canal. The mean volume of injected cement per verte-

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**Fig. 1.** Case 2. Studies obtained in a 53-year-old man with severe back pain and paraparesis (Frankel Grade C). A: Sagittal magnetic resonance (MR) image demonstrating T-4 and T-5 metastatic disease and cord compression. B: Axial CT scan obtained after open kyphoplasty revealing PMMA in the VB. C: Sagittal CT reconstruction obtained after open kyphoplasty demonstrating no leakage of the PMMA.
bra was 7 ml (range 3–9 ml). The mean LOS was 7 days (range 3–10 days). No problems with wound healing occurred. In nine of the 14 patients with metastatic vertebral fractures, adjuvant radiotherapy was instituted after a mean period of 15 days (range 15–21 days). The five other patients in this group had undergone radiotherapy before the vertebral fracture developed.

The mean follow-up duration was 10 months (range 7–16 months). Three months after the intervention one patient died due to the evolution of multiple myeloma, and one patient died 1 year after the procedure due to evolution of her breast cancer.

All patients underwent clinical and imaging assessment every 3 months during the follow-up period. All patients but one had stable imaging and clinical results at each review. This one patient (Case 7) suffered local evolution of her disease and spinal involvement cephalad and caudal to the initially treated vertebra.

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**Fig. 2.** Case 14. Studies obtained in a 57-year-old woman with breast cancer who presented with severe back pain and paraparesis (Frankel Grade D). A: Sagittal MR image demonstrating cord compression at T-11 caused by a metastatic lesion. B: Sagittal CT reconstruction revealing VB collapse. C: Postoperative sagittal CT reconstruction demonstrating improvement of the collapsed VB and reduction of the local kyphosis after open kyphoplasty and osteosynthesis.

**Fig. 3.** Case 17. Studies obtained in a 71-year-old man with a T-12 burst fracture. A: Sagittal MR image demonstrating spinal cord compression. B: Sagittal CT reconstruction revealing a T-12 burst fracture and severe kyphosis. C: Postoperative sagittal CT reconstruction demonstrating improvement of the collapsed VB and reduction of the local kyphosis after open kyphoplasty and osteosynthesis.
Open kyphoplasty

**Discussion**

Galibert and colleagues\(^1\) first introduced the percutaneous vertebroplasty involving injection of a local anesthetic approximately 20 years ago. The first application was in the treatment of vertebralangiomas; thereafter, it was used to treat bone metastatic lesions and osteoporotic fractures.

One of the complications of percutaneous vertebroplasty is cement leakage into the spinal canal,\(^13\) the incidence of which has been reported to be as high as 37.5% when vertebral metastases are treated.\(^4\) The incidence itself varies according to the treated level. In the high thoracic spine one group reported an 85.7% incidence.\(^13\) The two most frequently occurring causes of cement leakage are an insufficient polymerization of the PMMA cement and excessive injection of cement.\(^7\) The risk of cement leakage is lower when balloon-assisted kyphoplasty is used\(^1\) for the following reasons: the optimal cement volume can be judged when balloon-assisted kyphoplasty is used because of the void created during inflation.\(^2,4\)

It is precisely the risk of cement leakage into the spinal canal and the potential neurological complications that have stimulated some authors to consider percutaneous vertebroplasty to be contraindicated in certain cases, such as those involving spinal compression and those with more than 75% loss of vertebral height.\(^6,8\)

Surgical vertebroplasty was first described in 1999 by Wenger and Markwalder\(^16\) who performed transpedicular vertebroplasty during open surgery. They placed posterior instrumentation in one patient during the same intervention. The authors treated 10 patients and noted cement leaks in seven cases; none of the patients was symptomatic because the open procedure allowed decompression of the spinal cord and the nerve roots.

In 2004 Boszczyk et al.\(^2\) described a microsurgical open kyphoplasty technique performed via the interlaminary route; the clinical outcome was good and there were no major complications. The authors, however, reported five cases of cement leakage and two cases of dural lesions. The use of the transpedicular open procedure, such as that described in our series, seems to pose less risk of causing a neurological lesion than the interlaminary route, and even less of a risk when kyphoplasty is performed at the thoracic levels above T-7.

Singh et al.\(^14\) also performed the open balloon kyphoplasty via the transpedicular route in patients with osteoporotic fractures and spinal cord compression. Posterior instrumentation was necessary in seven (28%) of the 25 cases. The authors noted complications in five patients (20%), in two of whom (8%) they were severe with neurological involvement.

In our series in which the procedure was performed via the transpedicular route, we observed no incidents of cement leakage into the spinal canal or of lesion of the spinal cord.

Pulmonary embolism due to cement leakage can be a complication of open vertebroplasty.\(^3\) In our series no cement leakage into the vena cava or pulmonary embolism was observed.

Since the publication of the work by Patchell et al.,\(^11,15\) surgical decompression and postoperative radiotherapy have been the standard treatment for metastatic spinal cord compression. Indeed this procedure significantly improves neurological recovery, and patients who were ambulatory prior to the intervention have prolonged ambulatory independence. In patients with vertebral metastatic lesions and a relatively short life expectancy of 10 to 11 months, the objective of the treatment is to resolve neurological dysfunction, when present, or to avoid the development of such dysfunction, and to achieve pain reduction.\(^17,18\)

One of the most common surgical problems is blood loss requiring transfusion (mean blood loss 1500 ml); infectious and neurological complications have also been reported in 5% of the cases.\(^7\) The mean LOS is 10 days and varies between 2 and 79 days, depending on the type of surgery and

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**TABLE 1**

Summary of data obtained in 18 patients who underwent open kyphoplasty

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Primary Cancer/Lesion</th>
<th>Treatment Level</th>
<th>Instrumentation</th>
<th>Preop</th>
<th>Postop</th>
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the complications.7 Vertebrectomy may be indicated in certain cases, but in most patients with vertebral metastases the general condition is poor and the metastatic lesions are not solely located in the vertebral bodies. Aggressive treatment, combining anterior- and posterior-approach surgery, is normally reserved for cases in which the vertebral metastatic disease is localized.15 This technique is associated with a morbidity rate as high as 48% and a mean LOS of 24 days.15 Combining surgical decompression and stabilization improves the patient’s quality of life.7,15

The combined use of surgical decompression and kyphoplasty allows the alleviation of medullary compression and vertebral instability. Indeed, when a large part of the VB is deteriorated, a one-stage posterior instrumentation-augmented fixation procedure does not technically provide sufficient vertebral stability. The combination of same-session posterior fixation and kyphoplasty, however, yields efficacious stabilization and almost no morbidity or mortality. None of our patients received a blood transfusion, and the mean LOS was 7 days.

Conclusions

The findings in this small series of 18 patients underscore the efficacy and safety of a surgical procedure combining decompressive spinal surgery and kyphoplasty. The patients’ benefit is an improved quality of life.

References


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