*Acta Orthop. Belg.*, 2005, **71**, 467-471

*ORIGINAL STUDY*

# Distractible vertebral body replacement for the thoracic and lumbar spine

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**We retrospectively evaluated the results after corporectomy and vertebral body replacement in 40 patients with thoracic or lumbar spine collapse due to tumour osteolysis, unstable fractures, spondylodiscitis and Paget's disease. They underwent posterior transpedicular instrumentation followed 7 to 21 days later by vertebral body replacement with a distractible device, the "Obelisc" cage, filled up with autogenous/allogeneic bone graft. The mean residual kyphosis after surgery was only 13.8°. After a mean follow-up period of 16.3 months, there was a mean loss of correction of 1.1°. Perioperative complications occurred in 25 patients (62.5%)** ; **one died of septic schock, and the others were treated conservatively. Postoperatively, neurological improvement was noted in 8 patients. Using this *in situ* distractible vertebral body replacement system to achieve intraoperative stabilisation, neurological improvement and minimal postoperative displacement were achieved with an acceptable perioperative risk.**

**Keywords** :spine ; vertebral body replacement.

## INTRODUCTION

Vertebral body destruction can have various causes such as neoplastic osteolysis, fractures (osteoporotic and traumatic) and inflammatory diseases (spondylodiscitis and spondylitis) of the anterior column of the spine. Patients with spinal instability suffer from pain, immobilisation, kyphotic deformity and neurological deficits. Therefore, instability of the anterior column of the spine should be stabilised by restoration of the anterior spinal profile (*8, 10*).

Up to 70% of disseminated malignancies have metastases in the spine (*12*). The survival rates range from a few days to several years (*1, 7, 22*). Over the last decades, overall survival in cases with malignancy has improved owing to improved therapies, resulting in a higher number of patients presenting with advanced metastatic disease and bone destruction. The management strategy must take into account the prolonged survival. Radiotherapy plays an important role in spinal metastasis, but quadriparesis or paraparesis secondary to a pathological vertebral fracture often cannot be improved by irradiation alone (*24*). Especially in patients with malignant disease, vertebral body replacement may have to be considered in order to achieve immediate stability (*3*).

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Spine fractures Magerl type B or C (*18*), often complicated by spinal compression or secondary posttraumatic kyphosis, can benefit from an anterior approach for spinal decompression and restoration of the anterior column by interposition of a bone-filled titanium cage (*4*). Following single posterior instrumentation, 90% of the resulting forces will be transferred to the implant (*19*), which may result in implant failure and segmental kyphosis. Stoltze and Harms found secondary kyphosis of 8-20° in 70% of those patients undergoing single posterior instrumentation after vertebral fractures (*25*).

Spondylodiscitis can be treated conservatively in most cases. In selected cases with an unstable defect, an anterior-posterior surgical approach may be indicated with radical debridement, posterior instrumentation and anterior reconstruction with autologous bone (*14*), but the successful use of bone-filled cages is also reported (*25, 26*).

We present our first clinical and radiological results with a vertebral body replacement system in patients with spinal instability of various origins.

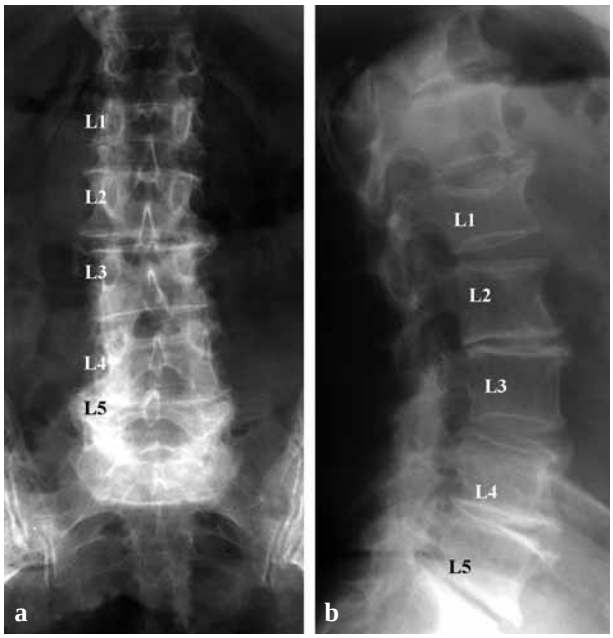


***Fig. 1a, b.*** — Preoperative x-rays of a 66-year-old female with an incomplete superior burst fracture of the first lumbar vertebra and subluxation of the facet joints (type B 1.2.3 according to Magerl *et al.* (*18*)). No neurological deficits.

## PATIENTS AND METHODS

Between November 2002 and November 2004, 40 patients with spinal instability of various origins underwent surgery for vertebral body replacement and stabilisation . Preoperative assessment included neurological examination, radiographs, magnetic resonance imaging (MRI) and computer tomography (CT) of the affected vertebrae. Postoperatively, radiological checks were performed to confirm correct implant position and subsequently CT scans to confirm fusion of the diseased area.

There were 26 men and 14 women. Their mean age was 56.9 ± 17.2 years (range : 20.5-82.7). The lesion was in the thoracic region in 16 cases, in the lumbar region in 23 and at the lumbo-sacral spine in one case. In total, 49 vertebral bodies were replaced. Vertebral body replacement was performed in 32 patients for one single vertebra, in 7 patients for two adjacent vertebrae and in one patient for three adjacent vertebrae.

Eighteen patients underwent surgery for a traumatic collapse, 10 for an osteoporotic fracture, 6 for malignancy, 5 for spondylodiscitis wih a massive defect not treatable by conservative means, and one for Paget's disease. Malignant lesions included two plasmocytomas, one B-cell-lymphoma , one low-grade malignant nerve-root tumour with infiltration and two metastases (bronchial carcinoma and tubular carcinoma).

A posterior transpedicular screw fixation of the neighbouring vertebrae was first performed in all cases, followed 7 to 21 days later by anterior reconstruction with an Obelisc® titanium cage (Ulrich, Spinal implants, Ulm, Germany) (fig 4, 5). This titanium system consists of one central cylindrical element and two attachments, available in different sizes and angles, with sharp teeth on their edges to avoid loosening. Distraction is achieved with a bevel gear drive unit, and is subsequently locked with a screw. Autologous or allogeneic/autologous bone graft was added in the cage in all cases. In 5 patients, the Obelisc system was supplemented with an additional antero-lateral plate-screw system MACS® (Aesculap, Tuttlingen, Germany).

The average follow-up period was 16.3 ± 5.2 months (range : 3.3 - 24.5). Clinical and radiological examinations were performed postoperatively and after 3, 6, 12 and 18 months. The local angulation ($\alpha$) was measured between the endplates of the adjacent vertebrae (fig 4). The physiological segmental angulation served as a reference (*2*).

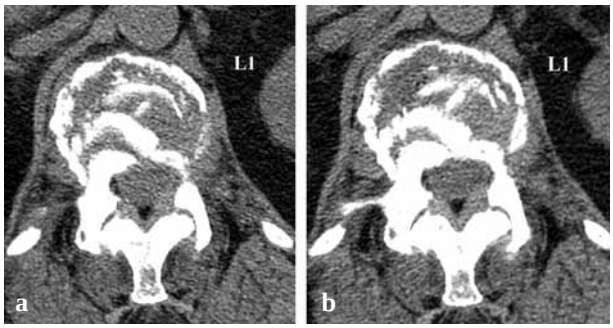


***Fig. 2a, b.*** — Preoperative CT at the level of L1 of the same patient : Traumatic incomplete superior burst fracture of L1, the endplate of the vertebra is totally destroyed, the posterior wall is involved.


***Fig. 3a, b.*** — Preoperative MRI (T1 and T2 Weighting) of the lumbosacral spine of the same female patient : Incomplete superior burst-fracture of the first lumbar vertebra. The posterior elements are ruptured ; the endplate is destroyed, including the posterior wall.

## RESULTS

The average operation duration for all patients was 140.4 ± 65.0 minutes (range : 62 - 420). The mean intraoperative blood loss was 962.5 ± 1009.3 ml (range : 100 - 6000) ; the mean postoperative blood loss was 440.8 ± 476.6 ml (range : 50 - 2100).

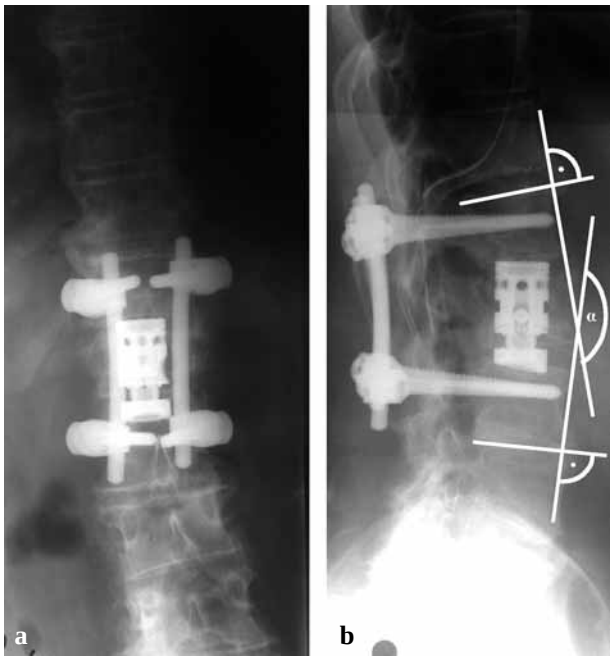


***Fig. 4a, b.*** — First postoperative x-rays of the same patient : The destroyed first lumbar vertebra is replaced by the Obelisc cage system. The *α-angle* determines the local kyphosis (angle between the endplates of the two adjacent vertebrae).

Eight patients (20%) showed neurological improvement according to Frankel's scale (*11*) as shown in table I ; none deteriorated.

After surgery, the patients stayed 5.1 ± 5.3 days (range : 1 - 24) in the intensive care unit. The total hospital stay was 62.3 ± 64.2 days (range : 7 – 265).

The local kyphosis was reduced to a mean value of 13.8 ± 10.5° (range : 2.4 – 46.3°). Loss of correction occurred mainly during the first 3 months ; at final follow-up, it amounted to an average value of 1.1 ± 3.4° (range : -7.3 – 7.5°) for the group as a whole, 0.7° in osteoporotic fractures, 1° in traumatic fractures, 1.2° in Paget's disease, 1.5° in pathological fractures due to malignancy and 1.6° in spondylodiscitis.

Complications : one patient died of septic shock ; 19 had a urinary infection, 6 developed bedsores, 5 respiratory insufficency, 5 pleural effusion, 2 deep venous thrombosis, 2 lung atelectasis, one haemothorax ; wound haematoma and wound dehiscence were noted in one patient each.

Table I. — Neurological status according to Frankel *et al* (*11*) preoperatively and after vertebral body replacement in all patients (n = 40)

| Neurological evolution according to Frankel *et al* (*11*) | | Postoperative | | | | |
|---|---|---|---|---|---|---|
| Preoperative | | A | B | C | D | E |
| A | 6 | 5 | | 1 | | |
| B | 0 | | | | | |
| C | 5 | | | 3 | 1 | 1 |
| D | 9 | | | | 4 | 5 |
| E | 20 | | | | | 20 |
| Total | 40 | 5 | 0 | 4 | 5 | 26 |

## DISCUSSION

Several conditions lead to spinal instability due to vertebral body collapse or destruction.

In *traumatic fractures*, depending on the defect size, an autogenous bone transplant or a cage filled with bone graft can be inserted to restore the anterior column. Dimar *et al* (*9*) used an autologous strut graft from the iliac crest in 84 patients, in combination with posterior instrumentation and fusion. They reduced the kyphosis to 14° but they lost 7° correction at final review, after a mean of 41 months, which is definitely more than the loss of correction noted in this study (1°), however after a longer follow-up period. Hollowell *et al* (*13*) tested the load to failure of titanium cages, tricortical iliac crest grafts and others, mounted on human cadaveric vertebrae : the titanium cages had the highest strength under load. These *in vitro* data do not allow for definitive conclusions. Transpedicular injection of hydroxypatite might become a simpler alternative.

In *osteoporotic fractures*, conservative treatment may also be considered, as well as vertebroplasty or kyphoplasty, which appear as promising alternatives (23).

In *malignant vertebral destruction*, surgery should be more or less extensive depending on the estimated life expectancy of the patient. With regard to spinal stability, anterior vertebral body replacement with a cage is superior to the single posterior instrumentation (*20*), but it should be reserved for patients with a life expectancy above

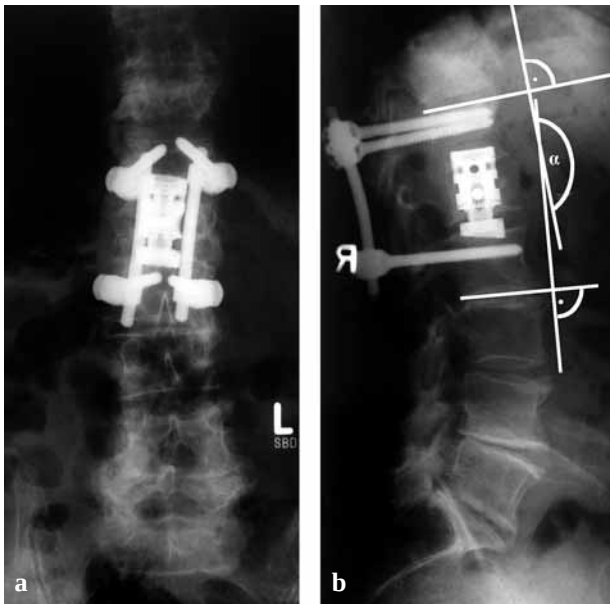


***Fig. 5a, b.*** — Postoperative x-rays of the same patient 18 months postoperatively : The loss of correction is shown by the increased local kyphosis ($\alpha$).

12 months. For patients with a worse prognosis, posterior instrumentation alone may be of use to reduce pain and neurological deficits (*5, 10, 16*).

Most cases of *spondylodiscitis* heal with antibiotic therapy, but large defects may be an indication for surgery. After radical debridement of the affected vertebra, some authors prefer to fill the defect with autologous or allogeneic cancellous bone (*14*), while others use titanium cages filled with bone grafts (*25, 26*), as was done in this series.

Well-fitting spacers leading to evenly distributed load transmission between the spacer and the supporting vertebrae can provide immediate stability. PMMA cylinders provide such an equal load transmission, but they bear a high risk of dislocation (*6*). Harms cages achieve close contact between grafts and supporting bone, but anterior distraction is necessary before implant insertion, imposing an unfavourable load on the vertebral screws (*13*). On the contrary, the Obelisc system is distractible *in situ*, and does not require the use of a supplementary distraction device. In situ distractibility was also seen as an advantage by Knop *et al* (*17*). Moreover, the Obelisc cage has spikes, the importance of which was stressed by Morlock *et al* (*21*) in

a study on human cadaver specimens. Kluba and Giehl (*15*) used a comparable device (VBR® Ulrich Spinal Implants, Ulm, Germany), also distractable *in situ*, and supplemented by posterior instrumentation, but filled up with PMMA. Their results were quite comparable to ours, with 0.9° loss of correction after 16 months ; however, they used a slightly different method of evaluation.

## CONCLUSION

*In situ* distractible vertebral body replacement systems allow for a stable customised restoration of the anterior column of the spine. Spikes prevent loosening of the cage. However, posterior instrumented distraction and transpedicular injection of hydroxyapatite might become a serious challenge.

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