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Clinical Case Studies

Implant in situ assembly for all-posterior lumbar vertebral column resection. Technical note

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ABSTRACT

Background: All-posterior lumbar VCR may be less invasive compared to combined retroperitoneal plus dorsal approaches. Stable lumbar vertebral body replacement requires implants with a large footprint to prevent implant subsidence. The narrow corridor between the lumbar nerve roots and the dural tube, however, impedes insertion of such implants via an exclusively posterior approach.

To overcome this problem, we performed implant in situ assembly, a new method that enables all-posterior lumbar vertebral column resection (VCR) using large endplates.

Methods: Four patients underwent all-posterior lumbar VCR and in situ assembly of the implant.

Results: All-posterior lumbar VCR and insertion of an implant with large endplates to support adjacent vertebrae was feasible in all cases.

Conclusions: Implant in situ assembly enables all-posterior lumbar VCR using large endplates.

Introduction

Replacement of lumbar vertebral bodies requires implants with a large contact area to the adjacent vertebrae to prevent implant subsidence. All-posterior lumbar vertebral column resection (VCR) reduces invasiveness compared to the commonly used combined anterior/lateral retroperitoneal plus dorsal approaches [1–3].

All-posterior VCR is widely used in the thoracic spine because the nerve roots can be sacrificed here, thus creating a larger corridor for implants with large endplates. In the lumbar spine, however, the nerve roots must be preserved and the narrow corridor between the nerve roots and the dural tube impedes insertion of implants with large endplates. This problem can be circumvented by in situ assembly of the implant. We report on the first four patients who underwent all-posterior lumbar VCR with in situ assembly of the implant.

Patients & methods

Written informed consent was obtained from all patients. Four patients with destruction of a lumbar vertebra due to metastasis, spondylodiscitis and osteoporotic fracture underwent all-posterior VCR and in situ assembly of the implant (Obelisc ®, Ulrich medical, Ulm, Germany). First, a complete laminectomy including the articular processes is performed via a midline incision of about 8cm in length. Then the pedicles are removed on both sides down to the level of the vertebral body. The cranial and caudal intervertebral discs are then sharply detached from the adjacent vertebrae and resected together with the collapsed vertebra. In case of a neoplastic process, a meticulous resection of the entire vertebral body structure is performed. End plates of appropriate dimensions (a diameter of 32mm was used in all cases) and with a suitable lordosis angle are then inserted vertically through the corridor of the previously resected pedicle (cranial to the segmental nerve root of the vertebra to be replaced) into the defect (Figs. 1 A+B and 2). The end plates are positioned against the adjacent vertebrae and the central element is inserted via the same corridor (Fig. 1C). Next, the endplates are clipped onto the central element and the implant is distracted to the desired height (Figs. 1D and 3). Finally, the segment is bridged with a percutaneously inserted pedicle screw and rod fixation system (Fig. 1E).

Results

All-posterior lumbar VCR with in situ implant assembly was feasible in all cases. Pre-operative T2-weighted MRI of the four patients are shown in Fig. 4 (upper row). Post-operative X-ray or computed tomography scans are shown below in Fig. 4 (lower row). No new postoperative deficits occurred and all patients were ambulatory after several days. Correction of kyphotic deformity / reconstruction of normal spine curvature was successful in all patients.

Discussion

All-posterior lumbar vertebral body resection for metastasis was reported in 1988 by Magerl et al [4]. A purely posterior vertebral decom-

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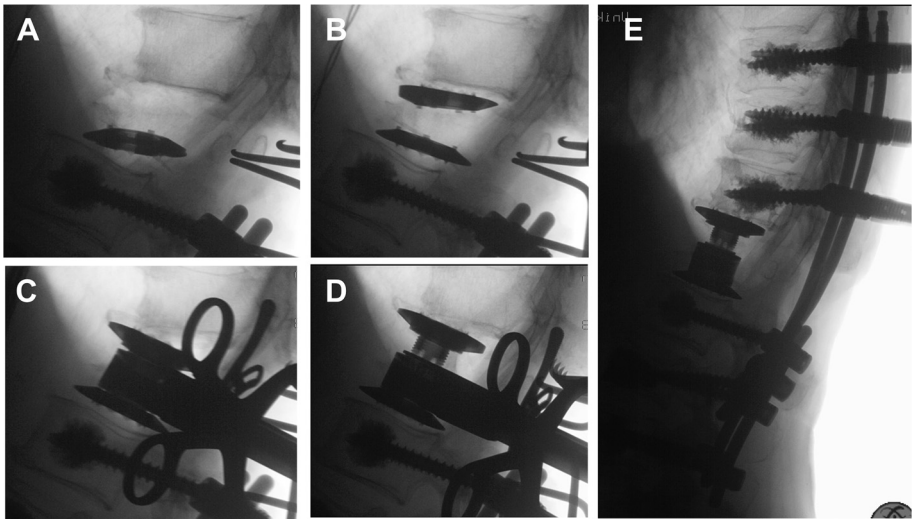

Fig. 1. A+B: After complete resection of the L1 vertebral body and the discs via a posterior midline access, endplates with a diameter of 32mm are inserted vertically through the axilla of the Th 12 nerve root and cranial to the L1 nerve root and positioned against the adjacent vertebrae (Th 12 and L2). The distraction element is inserted and the endplates are clipped on (C). The implant is distracted to the desired height (D). A pedicle-screw and rod system bridging the VCR is implanted percutaneously (E).

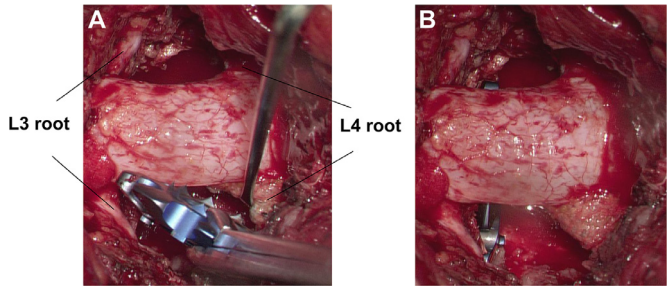

Fig. 2. Intraoperative photographs showing vertical insertion of a 32mm diameter endplate through the corridor between the L3 and L4 root and the dural tube (A) into the VCR defect after resection of L4 and the adjacent discs. The endplate is positioned against the central surface of L3 (B). The L4 nerve root is protected with gelfoam.

pression / resection and defect filling to support the anterior spinal column using a polymethyl methacrylate inlay was suggested for terminally ill patients. This technique was developed to reduce the invasiveness of the alternative - a combined retroperitoneal and dorsal approach.

At the beginning of the 2000's, all-posterior thoraco-lumbar vertebral column resection was introduced into the management of patients with spinal deformity [2], again aiming at a lower morbidity compared to the classic combined lateral plus dorsal approaches which featured complication rates as high as 50%, considerable blood loss and operative times [5,6]. Potential severe complications of lateral approaches include visceral, vascular and lymphatic injury as well as pneumothorax or a pleural CSF fistula.

Several studies reporting nearly 400 patients with all-posterior thoraco-lumbar vertebral column resection for the treatment of spinal deformity / scoliosis are available [7]. These studies included young patients and bony fusion of the reshaped spine is the therapeutic goal. A (slim) tubular titanium mesh graft in combination with morsellized bone is commonly used for reconstruction of the anterior column.

In older patients or those with poor bone quality for other reasons, vertebral body replacement implants to fill VCR defects must be equipped with large end plates in order to prevent implant subsidence. All-posterior VCR and insertion of implants with a larger footprint has become common practice at the thoracic spine and the first lumbar vertebra where the nerve roots can be sacrificed. In combination with a (complete or partial) costotransversectomy this opens a corridor wide enough to use implants with a large footprint and low rates of implant subsidence have been reported [8].

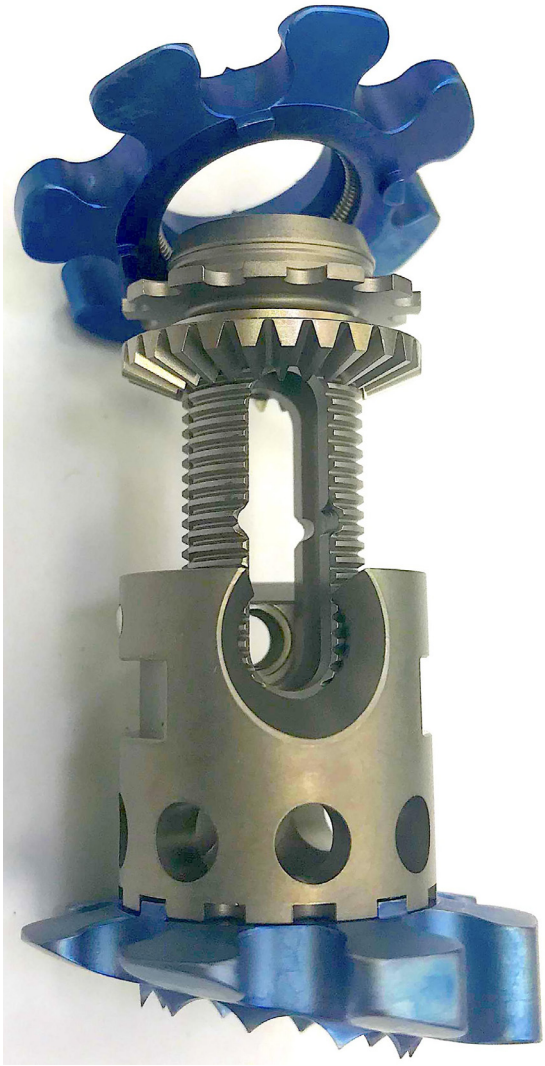

Fig. 3. Photograph of the Obelisc ® (Ulrich medical, Ulm, Germany) thoracolumbar vertebral body replacement implant featuring a clip-on design of the endplates which enables in situ assembly.

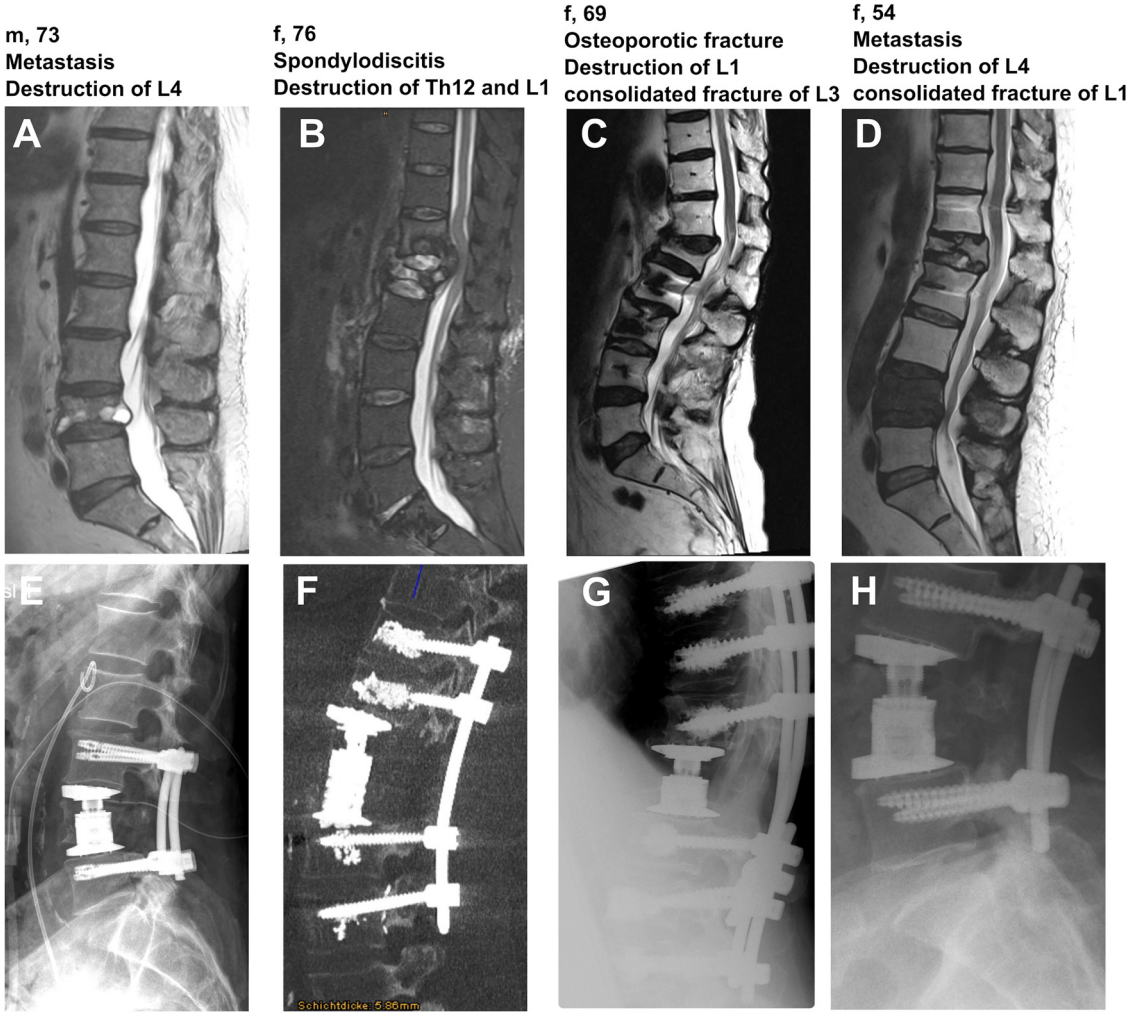

Fig. 4. Upper row: Preoperative sagittal T2 weighted MRI of the lumbar spine of four patients show complete destruction of one or two vertebrae. Lower row: Post-operative X-ray or CT show 360° vertebral column resection and defect filling and deformity correction with an in situ assembled vertebral body replacement implant with 32mm diameter end plates.

In the lumbar spine, however, the all-posterior approach offers limited space for the insertion of an implant with a large footprint, as the nerve roots must be preserved to prevent motor deficits.

Here, we introduce implant in situ assembly to overcome these limitations and enable implantation of vertebral body replacement implants with large end plates to fill lumbar VCR defects. Appropriately sized endplates can be vertically inserted through the corridor between the lumbar nerve roots and the dural tube (i.e., the pedicle resection defect). The central element is then inserted, the end plates are clipped on and the implant is distracted.

By its very nature, this method places specific demands on the vertebral body replacement implant: in-situ assembly is only possible if a clip-on design of the end plates is available. The vast majority of thoracolumbar vertebral body replacement implants were designed for insertion via transthoracic or retroperitoneal approaches. Accordingly, the end plates are screwed to the central element, typically from an angle that makes in situ assembly impossible (i.e., vertically to the central element). The Obelisc® by Ulrich medical (Ulm, Germany) features a clip-on design of the endplates and, thus, allows in situ assembly of the implant. Furthermore, the end plates can be mounted at variable angles, allowing a flexible access angle to be selected for insertion of the central element.

The main surgical challenge of a purely posterior lumbar VCR is the accurate dissection of the surfaces of the adjacent vertebrae. Resection of the lower disc typically must be performed through the axilla of the nerve root requiring meticulous dissection of the nerve structures and outmost care to prevent neural injury. A near-complete resection of all bony elements of the pedicle and vertebral body is required to gain enough space for insertion of the central element.

So far, our experience with the new process is limited to the cases reported here. The advantages and disadvantages require closer observation in further patients. Currently, we see a great opportunity in the new method to reduce the invasiveness of lumbar VCR.

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Declaration of Competing Interest

The authors report no conflict of interst.

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