Management of fractures of the pedicle after instrumentation with transpedicular screws

A REPORT OF THREE PATIENTS

F. Lattig, T. F. Fekete, D. Jeszenszky
From the Schulthess Clinic, Zürich, Switzerland

Fracture of the pedicle is a rare complication of spinal instrumentation using pedicular screws, but it can lead to instability and pain and may necessitate extension of the fusion. Osteosynthesis of the fractured pedicle by cerclage-wire fixation and augmentation of the screw fixation by vertebroplasty or temporary elongation of the fixation, allows stabilisation without sacrifice of the adjacent healthy segment. We describe three patients who developed a fracture of the pedicle in the most caudal instrumented vertebra early after lumbar spinal fusion.

During revision surgery the pedicles were reduced and secured by a soft cerclage wire bilaterally. Fusion was obtained at the site of the primary instrumentation and healing of the pedicles was achieved. Cerclage wiring of the fractured pedicle seems to be safe and avoids permanent extension of the fusion without the sacrifice of an otherwise healthy segment.

Fracture of the pedicle is a rare complication of lumbar spinal instrumentation and is typically identified intraoperatively.1-5 The literature contains only one case report describing a Chance fracture,6 which is a compression-distraction-injury with horizontal splitting of the vertebra, involving both pedicles at the lowest instrumented vertebra. This occurred early in the post-operative course after correction of a kyphosis.7 One other case is reported of a revision of spinal fixation because of pain in which the pedicles on one side of L3 and L4 showed a break in the medial wall.7 If the fracture of the pedicle occurs in a vertebra which is strategically important for the stability of the instrumentation, extension of the fusion is the conventional and easiest way to restore stability.1,7 However this requires the sacrifice of a healthy segment.

We describe three patients with bilateral pedicular fractures involving the most distal instrumented vertebra of a lumbar fusion, who underwent revision surgery by osteosynthesis of the pedicles and additional vertebroplasty through cannulated screws in one, and temporary extension of the instrumentation without fusion in two.

We believe that this is the first description of a technique for a pedicular osteosynthesis using cerclage-wire fixation for a fractured instrumented pedicle as a means of restoring stability without extension of the fusion.

Patients and Methods

Patient 1. A 75-year-old man with three-level degenerative spondylolisthesis and spinal stenosis was treated by decompression, posterior stabilisation and transforaminal lumbar interbody fusion of L2-5. At one week post-operatively CT was performed because of progressive low back pain, an L5 radiculopathy and slight loss of lordosis at L4-5 which was not seen on the intra-operative radiographs. Reformatting of the CT in the coronal and sagittal planes showed pedicular fractures at L5. Revision surgery was performed 12 days later with cerclage wiring of the pedicles and replacement of the pedicle screws at L5 with cannulated screws, through which a vertebroplasty of L5 was performed (Fig. 1).

Patient 2. A 74-year-old woman complained of progressive back pain when weight-bearing six days after a correction spondylodesis of T11-L5 with transforaminal lumbar interbody fusion at L4-5 for a decompensated degenerative deformity. The post-operative radiographs showed bilateral pedicular fractures at L5 with deviation of the fixed spinal segments to the right, and slight unilateral subsidence of the cage. One week after primary surgery revision was undertaken by osteosynthesis of the L5 pedicles and elongation of the instrumentation to S1 without fusion at L5-S1. At eight months after operation the L5-S1 segment was released revealing no loss of mobility on intra-operative testing. Stability of the L4-5 segment was achieved.
Patient 3. A 52-year-old woman had spinal claudication and back pain. A decompression and fusion of L2-5 was performed with pedicular screws and transforaminal lumbar interbody fusion at each level. On initial mobilisation she complained of increasing back pain and sciatica, which was relieved by bed rest. The anteroposterior and lateral radiographs showed a fracture of the L5 pedicles. A revision operation was carried out eight days after the primary intervention by osteosynthesis of the L5 pedicles with cerclage wires and temporary extension of the posterior stabilisation to
S1. The screws in S1 were removed at five months after healing of the pedicular fracture had been confirmed by CT (Fig. 2).

Operative technique. The technique of osteosynthesis of a pedicular fracture can be used in primary and revision surgery. Under general anaesthesia the patient is placed prone. The posterior elements of the spine and the instrumentation are exposed and the rods and screws present at the fractured pedicles are removed. The transverse process and the upper and medial borders of the pedicle are exposed. If the fracture is at the lowest instrumented vertebra or any level of the fusion, the facet joints of the involved segment will normally have been excised or partially resected by performing a posterior lumbar interbody fusion or posterior fusion. If the pedicular fracture affects the most proximal instrumented vertebra, the facet joint should have been spared. The direction of the fracture is determined and any debris between the fragments is removed. The position of the cerclage wire depends on the direction of the fracture and which bony structures have been preserved. Best compression is achieved if the cerclage wire lies perpendicular to the fracture. Figure 3 shows two possible positions for the cerclage wires which are most easily inserted when soft wire is used. After tightening the cerclage wire and closure of the fracture gap, further treatment depends on the stability acquired. When performed in this way if the fracture of the pedicle occurs during primary surgery, no further additional steps should be necessary. However, in cases of revision surgery with loss of lordosis because of subsidence of the pedicular screws or the anterior support, the pedicular cerclage alone may not be sufficiently strong to restore stability and alignment. In these situations, re-positioning of the pedicular screws, the use of cannulated screws with injection of bone cement into the vertebra or temporary extension of the instrumentation to the next vertebra without fusion, are further options. If a temporary extension of the posterior instrumentation to the next segment is carried out, it can be removed once the spinal fusion has occurred and the pedicular fracture has healed.

Results
In all six fractured pedicles it was possible to apply a soft cerclage wire almost perpendicular to the fracture line with near complete closure of the fracture gaps on visual inspection. Type-1 positioning of the cerclage wire was used four times and type-2 positioning on two occasions (Fig. 3). The intra- and post-operative measurements of the lordosis and scoliosis (Cobb) angles are given in Table I.

After revision, the loss of lordosis and/or progressive scoliosis was corrected and maintained. No laceration of the dura or injury to the nerve roots occurred. In all three patients there was immediate relief from the back and leg pain which had developed after the primary surgery. By follow-up at three months, no breakage or displacement of the cerclage wires or loosening of the pedicular screws in the fractured pedicles was observed. CT showed healing of the pedicular fractures.
Discussion
The placement of pedicular screws is associated with several complications.1-5 One rare event is a fracture of the pedicle which is generally observed intraoperatively. Lonstein et al5 reported only three such fractures out of 4790 pedicular screw insertions, and only one in which a fractured pedicle was found at two levels on one side during revision surgery. The fracture had not been seen clearly on CT or myelography before revision. The screws were left in place. No further information was given about the stability of the instrumentation. Esses et al2 reported a rate of pedicular fractures, observed intraoperatively of 2.3% (14 of 617 patients). Of the post-operative complications which have been reported, failure of the screws occurred in nine patients. It is conceivable that in some of these patients an additional fracture of the pedicle may have occurred, but this was not specifically examined. No treatment options were discussed either for the pedicular fractures which occurred intraoperatively or for the post-surgery failures of the implant. Unilateral fracture of a pedicle at L5 was observed intraoperatively in two patients by Blumenthal and Gill.1 In both cases stability was achieved by extension of the instrumentation to the sacrum and bridging of a healthy segment. We identified only one case report of a Chance fracture through the lowest instrumented vertebra (L4) of a patient with athetoid cerebral palsy, who had been treated for a progressive thoracic kyphosis by pedicular screw fixation.2 Stability was restored by extending the fusion to the sacrum.

In none of our patients was the fractured pedicle identified intraoperatively. We believe that the fractures had not been overlooked previously since the patients developed new back pain, with associated sciatica in some, during mobilisation after the primary surgery and since bilateral fractures occurred at the lowest vertebra of a long instrumented construct. Lateral bending and loss of lordosis of the lumbar spine were signs of failure of the instrumentation. In two patients the anteroposterior and lateral radiographs showed the fracture. In the other patient, only CT revealed the horizontal fracture line.

Fixation by cerclage wires is a widely used technique for periprosthetic fractures in the upper and lower limbs9,10 and has been applied to the proximal phalanges in the fingers.11 The pedicles provide the most important anchorage points of the vertebra for pedicular screws,12 but restoration of the integrity of the pedicle is crucial for firm engagement of the screw. This is especially so for a strategically important pedicle at the ends of a fusion. If a crack in the pedicle is detected intraoperatively and is unilateral within the instrumented region, then no additional fixation is necessary. In our opinion, if this occurs at the end of an instrumented region and is recognised intraoperatively, cerclage wiring of the affected pedicle could be used as a stand-alone stabilising procedure. However, this needs to be examined in further investigation. In our three patients, bilateral fracture of the pedicle occurred in the lowest instrumented vertebra of a long fusion construct. Loosening of screws and pseudarthrosis are known to be the main complications at the ends of longer fusions13 reflecting the higher bending stresses experienced by such segments. For this reason we anchored the pedicular screws in bone cement in one patient and temporarily extended the stabilisation to the next segment until fusion had been achieved in the others. This technique allowed stability to be restored and solid fusion to occur without the sacrifice of a healthy segment.

The authors wish to thank A. Mannion for assistance in the preparation of this manuscript.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References