Alternative Technique of Cement Augmentation of Loosened Pedicle Screws – Technical Note and Presentation of Two Cases

Alternativní technika cementové augmentace uvolněných pedikulárních šroubů – technická poznámka a prezentace dvou případů.

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SUMMARY

An alternative cement augmentation technique for pedicle screws is described, which was applied in two patients with mono- and bisegmental non-union after preceding multisegmental lumbar fusion. The correctly placed pedicle screws in S1 with diameters of 6 and 8.5 mm had severely enlarged the screw cavities due to segmental instability. Revision screws with 10 mm diameter demonstrated sufficient purchase only on the left side. Therefore, cement augmentation was performed for the right sided screws. After verification of intact pedicle borders, the cavity was filled up with PMMA bone cement. Afterwards, a Kirschner wire was positioned centrally, the hardening of the cement was awaited, the cement was gradually drilled and the screw was placed. In both patients, sufficient purchase of the cemented pedicle screws was documented. Screw insertion after awaiting the hardening of the bone cement in pedicles and vertebral bodies with huge defect situations seems to be an alternative to previous cement augmentation techniques of pedicle screws with the advantage, that the screws could be more easily unscrewed, if necessary.

Key words: bone cement, augmentation, pedicle screws, revision, spondylodesis.

INTRODUCTION

The biomechanical stability of pedicle screws is mainly determined by the pedicle cortex and can be defined as the pull-out strength, which is even used in osteoporotic bone (6, 7). By the possibility of cement augmentation, which is already applied in primary situations for the treatment of the osteoporotic spine, a higher pull-out strength can be achieved (11).

With increasing number of revision surgeries for pseudarthrosis in lumbar spondylodesis biomechanical studies attended to the improvement of screw purchase in revised pedicle screws (1, 9, 10).

In addition to the feasibility of a larger screw diameter, of a new screw placement with another direction or of an extended fusion distance, cement augmentation is recommended in revision situations like in primary fusions (8).

So far, two procedures were described for augmenting the pedicle screws with cement. With the first method the screw is turned into the still soft cement in the vertebral body after preparation of the screw canal (4). With the second method the cement is applied via the implanted perforated and cannulated screw (5). Both techniques were basically implemented during primary implantation of pedicle screws in osteoporotic bone (4, 5).

In this report a new technique of cement augmentation for pedicle screws with extensive screw loosening in revision situations is described in detail and illustrated in two patients. Its advantages are the independence of the screw placement of the hardening of the cement and the possiblity to unscrew the pedicle screws more easily.

DESCRIPTION OF THE CEMENT AUGMENTATION TECHNIQUE

Pseudarthrosis with pedicle screw loosening in S1 in longer fusion constructs crossing the lumbo-sacral junction could result in an extremely enlarged screw cavity.

Because of the main stressing in the direction of flexion – extension, the cavity is often elliptical-shaped with the maximum diameter at the base (Fig. 1).

After verification of intact pedicle borders, the screw cavity is accurately debrided by removing the scar tissue and opening the cancellous bone. Then, a Kirschner wire (K-wire) is prepared with a threaded swab or a special device (Fig. 2a). Afterwards, high viscosity PMMA bone cement is inserted under pressure in the cavity, the K-wire with the threaded swab is positioned centrally, and the hardening of the cement is awaited (Fig. 2b). With the aid of the swab or cannulated device both the K-wire can be kept centric in the cavity and the cement can be compressed during the hardening.

After this, the K-wire is removed, the cavity is gradually reamed with a 2.0 mm, 2.5 mm, 2.7 mm, and 3.2 mm drill and then tapped until the diameter of the inserted screw. Alternatively, a K-wire with a larger diameter can be used, though the drilling and tapping process will be shorter.

CASE REPORTS

Case 1

Fusion T10-S1 with decompression L3-S1 was performed in a patient at the age of 76 in October 2008 due to thoracolumbar scoliosis with spinal stenosis. At last, the patient had increasing back pain with radiologically pseudarthrosis L5/S1 with significant instability and loosening of both screws in S1 (Fig. 3a).

After additional CT and MRI examination, partial removal of the hardware, new instrumentation with accessory instrumentation of both sacral ala, implantation of thicker screws in L5 and S1 on the left side and cement augmentation of the right pedicle screw in S1 was performed in February 2011. The X-rays at 1-year follow-up confirmed stable conditions of the fusion construct (Fig. 3b).

Case 2

PLIF (Posterior Lumbar Interbody Fusion) and decompression L3-S1 were performed in a patient at the age of 67 in March 2009 due to lumbar osteochondrosis with spinal stenosis. In June 2009 pedicle screws L4-S1 were changed by reason of infection. During further progress, the patient complained of persistent lumbar pain. Radiologically, asymmetric osteochondrosis L2/3 and pseudarthrosis L3/4 and L5/S1 with loosening of both screws in S1 were detected (Fig. 4a).

After completing the diagnostic investigation with CT and MRI, removal of the hardware, new instrumentation and extension of the instrumentation up to L2, posterior re-fusion in L3/4, TLIF (Transforaminal Lumbar Interbody Fusion) L2/3 and also L5/S1 with cement augmentation of the right pedicle screw in S1 were performed in May 2011. As marked widening of the right pedicle screw cavity in S1 was intraoperatively observed and there was no purchase even of a revision screw with a maximum diameter of 10 mm, a cement augmentation of the screw was carried out. The X-rays at 1-year follow-up showed also a stable revised situation (Fig. 4b).

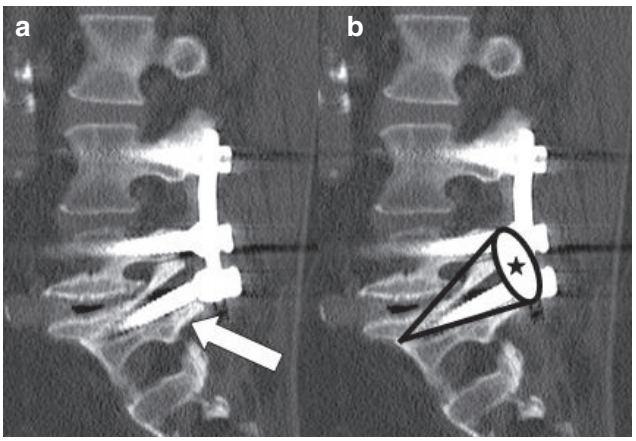

Fig. 1. CT-scan reconstruction of a patient with a pseudarthrosis L5/S1 and screw loosening in S1 (=>). Due to the main force direction in the flexion – extension bending the screw cavity is extremely enlarged in an elliptical shape with the maximum diameter at the base (*).

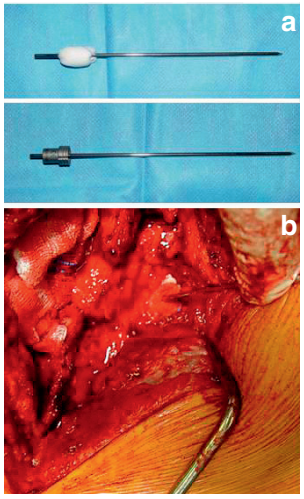

Fig. 2. A K-wire is prepared with a threaded swab or a titanium cover (a). Centrally positioned K-wire with the threaded swab in already inserted cement, which filled up the right screw cavity in S1 (b).

In both patients, pedicle screws with diameters of 6 mm were placed in S1 on the right side, which had a stable purchase in each case. The postoperative CT images of Case 2 confirmed sufficient cement covering of the S1 screw on the right side (Figs 5a-c).

DISCUSSION

For cement augmentation of pedicle screws especially in primary situations like in osteoporotic vertebra two methods were described. On the one hand, the screw can be inserted in the still soft cement without creation of a cavity in the vertebral body with the "vertebroplasty technique" or with previous creation of a cavity with the "kyphoplasty technique" (2, 4). On the other hand, cement augmentation can be performed via an implanted perforated and cannulated pedicle screw (3, 5).

From our point of view, the considerations about cementation techniques in primary situations are rarely transferable to revision situations like in this report.

In both patients, rather sclerotic walls were existent after removal of the loosened screws, which avoid typical spreading of the cement in the trabeculae and can lead to poor purchase of new pedicle screws. Furthermore, the cavity of the

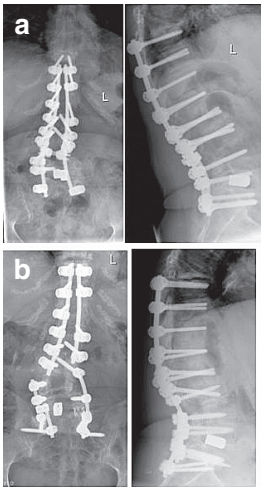

Fig. 3. Case 1: Preoperative X-rays (Posterior fusion T10-T12, ALIF L1-L5, PLIF L5-S1, and old T9 fracture with regional hyperkyphosis) with pseudarthrosis L5-S1 and loosening of both screws in S1 (a). Postoperative X-rays after removal of the hardware L3-S1 on the left side and L4-S1 on the right side with rod transection, new instrumentation with accessory instrumentation of both sacral ala, removal of the left cage in L5-S1, autologous bone grafting in L5-S1 with application of a new titanium cage, cement augmentation of the right pedicle screw in S1, and application of a 10 mm S1 screw on the left side. Stable conditions at 1-year follow-up (b).

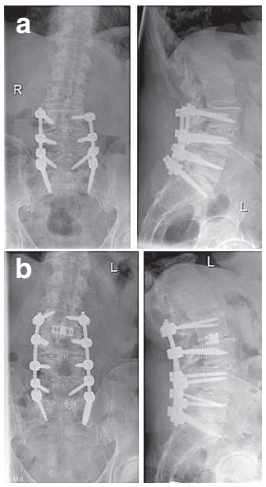

Fig. 4. Case 2: Preoperative X-rays (PLIF L3-S1) with non-union L3/4 and L5/S1 with halo zones surrounding loose screws in S1 and osteochondrosis L2/3 with malposition (a). Postoperative X-rays at 1-year follow-up with stable conditions after revision surgery in terms of removal of the hardware, new instrumentation up to L2, TLIF L2/3 and L5/S1 with cement augmentation of the right pedicle screw in S1, and application of a 10 mm S1 screw on the left side (b).

loosened screw in S1 has an elliptical shape with the largest diameter at the entry point of the screw in the direction of flexion – extension – movement. If perforated and cannulated pedicle screws would be inserted, only the enlarged cavity in the vertebral body could be sufficiently filled up with cement, compared to the even larger cavity in the pedicle.

With the described alternative cement augmentation technique sufficient cement filling both in the vertebra and in the pedicle is possible and no high cement application pressure is necessary. Another advantage is, that the screw is not turned in the still soft cement like a "curl". In this way, less stable screw purchase could result due to possible less interconnection, especially between cement and bone. Also, turning back of the screw could potentially be associated with the risk of co-rotating and loosening the surrounding cement. And furthermore, there is no temporary limitation between cementation and screw insertion, though several cavities could be cemented stressless simultaneously.

The presented cement augmentation technique of loosened pedicle screws is based on experiences of one of the authors (F. L.). Biomechanical studies are already designed at our institution, which should investigate the stability and anchorage of pedicle screws after different cementation procedures.

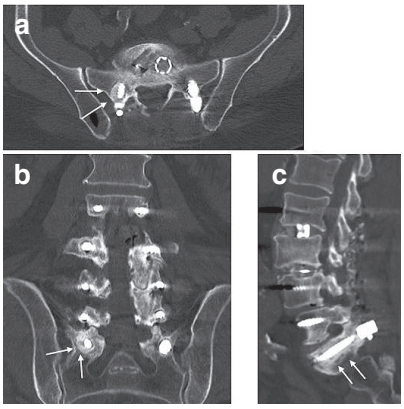

Fig. 5. Postoperative CT images of Case 2 with transversal (a), coronary (b) and sagittal (c) reconstructions. The pedicle screw in S1 on the right side is surrounded by sufficent cement covering (arrows) in the vertebra and the pedicle.

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