Multiple revisions of a L2 burst fracture in a suicide jumper: a retrospective analysis of what went wrong

P. Gahr · S. K. Tschöke · D. Haschtmann ·
Christoph-E. Heyde

Accepted: 24 April 2009 / Published online: 3 June 2009
© Springer-Verlag 2009

Abstract

A 35-year-old female patient sustained three contiguous vertebral fractures at the thoracolumbar junction while jumping off the third floor in a suicide attempt. Initial fracture treatment occurred in the setting of a multiple injury

scenario. While the Th12 and the L1 vertebral fractures were considered stable, the L2 fracture exhibited a complete burst configuration with 80% canal compromise due to a posterior wall fragment causing paraplegia. A posterior pedicle screw stabilisation with indirect fracture reduction was carried out initially from T12 to L3. At 1 year follow-up the patient presented to us for new onset radiculopathy L2, and loss of correction. A circumferential revision surgery with an expandable cage was carried out to restore the anterior and posterior columns. Unfortunately again loss of reduction with kyphosis occurred, this time at the upper instrumented vertebra, which made another revision necessary. In this situation a longer construct was chosen using a combined approach and a Mesh cage. This later procedure was complicated by a postoperative paraparesis believed to be vascular in origin. Six months later a further complication involving MSSA deep wound infection required a series of irrigation debridement for healing. At the 2.5 years follow up the spine was stable and the patient had a neurologic recovery allowing her to ambulate with crutches. This Grand Round Case raises the question on the initial management of multiply injured patients with spine fracture, the classification of these fractures, the optimal initial internal fixation, the need for complementary anterior column reconstruction and the strategy when all these fails.

A comment on this article Grand Rounds is available at doi:[10.1007/s00586-009-1026-5](https://doi.org/10.1007/s00586-009-1026-5).

P. Gahr
Department of Orthopaedic and Trauma Surgery,
Charité, Campus Benjamin Franklin, Hindenburgdamm 30,
12200 Berlin, Germany

D. Haschtmann
MEM Research Center for Orthopaedic Surgery,
Institute for Surgical Technology and Biomechanics,
University of Bern, Bern, Switzerland

S. K. Tschöke · C.-E. Heyde (✉)
Department of Orthopaedic Surgery,
University Hospital Leipzig, Liebigstrasse 20,
04103 Leipzig, Germany
e-mail: Christoph-Eckhard.Heyde@medizin.uni-leipzig.de

Case presentation

A 35-year-old woman was admitted to an external emergency department after a fall from 10 m height. The patient was unconscious with a Glasgow Coma Scale of six (GCS = 6) on site. During intubation she was able to move her arms, but not the lower extremities, so that a traumatic paraplegia was suspected. The trauma management was

Fig. 1 Sagittal reconstruction and axial view of the CT scan showing the burst type of fractures. The fracture of L2 exhibits a segmental kyphosis and a significant spinal stenosis

performed according to the ATLS® guidelines. The secondary survey revealed multiple injuries including several thoracolumbar spine fractures (Th12, L1 and L2) (Fig. 1), a subarachnoidal haemorrhage, bilateral pulmonary contusions, fractures of the 9th and 10th left rib, talus fractures on both sides and an avulsion of the medial epicondyle of the left elbow joint. The Injury Severity Score added up to 27 (ISS = 27). The lung contusion and intracranial haemorrhage were treated conservatively, the talus

fractures and elbow injury were operated later after stabilisation of the general clinical condition. Past medical history was significant for a postpartum psychiatric depression. The spine fracture was treated with an open fracture reduction and posterior pedicle screw instrumentation from Th12–L3 without direct decompression of the spinal canal (Fig. 2). Postoperatively, the paraparesis showed a complete regression within 1 week. At discharge the woman had fully recovered from CNS trauma and was walking on crutches in Allgoewer's splint apparatuses on both sides.

After 1 year the patient presented to us with severe back pain at fracture site and right leg pain. Neurological examination revealed numbness at the anterior thigh and a weakness of hip flexion related to an L2 radiculopathy. X-rays and MRI demonstrated a loss of reduction with kyphosis at L2 and recurrent central stenosis and foraminal stenosis of L2/L3 on the right side with nerve root compression (Fig. 3). At this time a combined anterior and posterior stabilisation from L1 to L3 was performed (Fig. 4). Postoperatively the L2 radiculopathy disappeared.

However, as demonstrated in Fig. 5, a collapse of L1 occurred 6 months later with increasing kyphosis and incapacitating back pain. Neurology remained normal. This prompted to a second revision with extension of instrumentation from Th11 to L4 (Fig. 6). This was followed by an incomplete paraplegia and with a sensory level below Th11 starting 3 h postoperatively. As this complication was suspected to be caused by an ischaemia, the treatment of choice was conservative with corticoids, hemodilution with HES and anticoagulation with heparin. The emergently performed MRI scan showed a myelon infarction at the level of Th10/11 confirming the diagnosis of a spinalis anterior syndrome (Fig. 7). As soon as possible the patient was referred to a paraplegic centre and a partial recovery of neurological symptoms was achieved over 3–4 months.

Six months later the patient was again referred back to us for a deep infection with a spondylodiscitis at the level L1 to L3. She suffered from increasing low back pain. Leucocytosis was present and her CRP elevated. Her neurological status at this time was stable. Several local debridements and drainage of a psoas abscess done earlier had been unsuccessful to cure the infection. The patient was therefore readmitted to our department. Microbiological examination revealed a methicillin-sensitive *Staphylococcus aureus*, which was treated by Flucloxacillin over a period of 12 weeks. The radical debridement involved removal of the cage, a partial corporectomy of Th12, a debridement at all previously instrumented levels and a new vertebral body replacement using the Harms-cage. Extending from L3 to the mid-portion of T12, the posterior instrumentation was left intact (Fig. 8).

Fig. 2 Postoperative X-ray of the thoracolumbar junction after reposition and dorsal instrumentation Th12 to L3

Fig. 3 One year postoperative roentgenogram demonstrated a loss of reduction with kyphosis of 12°. The sagittal MR imaging demonstrated a spinal stenosis at the fracture level L2

Fig. 4 X-ray after dorsoventral revision surgery with posterior instrumentation L1–L3 and partial corpectomy with vertebral body cage replacement and additional ventral rod instrumentation. The spinal alignment is well reconstructed, implant positioning is correct

Fig. 5 Lateral X-ray and MRI scan demonstrates the vertebral body collapse of L1 and the resulting kyphosis above the instrumentation. The dorsal shift of the posterior wall fragment causes a spinal stenosis

Diagnostic imaging section (Figs. 1, 2, 3)

Overview of spine fracture in the “jumpers”

The thoracolumbar junction, which ranges from the 11th thoracic to the 2nd lumbar vertebra is the most common site of injuries to the thoracic and lumbar spine. The main cause for this fact is the abrupt transition from the rigid thoracic spine to the flexible lumbar spine. Up to 20% of the injuries to the thoracolumbar spine are complicated by neurological deficits [3]. The injury pattern of suicidal jumpers differs markedly from the type observed after traffic accidents or even from the unintended falls from

great height. The typical unintended falls result in an impact on the back with thoracic and CNS trauma. Most suicide jumpers, however, land on their feet, which leads to severe injuries of the lower extremity, the pelvic rim and the lumbar spine while head injuries are relatively rare [6]. According to Roy-Camille et al. [5] upper transversal sacral fractures are named “suicidal jumper’s fractures” as they typically occur after a fall from great height onto the lower extremity. Serial vertebral fractures of the thoracolumbar spine are quite common injuries. In their retrospective analysis of 56 cases with thoracolumbar fracture and posterior stabilisation, Knop et al. [3] reported injuries of more than two segments in 27% of their cases.

Fig. 6 Status post-second ventrodorsal re-instrumentation. The X-ray pictures document correct implant positioning and a good spinal alignment. CT shows no signs of remaining spinal stenosis

Following posterior stabilisation the authors found a mean loss of reduction of 63%, which lead to the recommendation to choose a combined anteroposterior approach in burst fractures.

Rationale for treatment and evidence-based literature

Rationale for first surgery

This multiply injured patient was initially managed according to the ATLS® guidelines. In the presented case spinal injury was highly suspected due to the mechanism of injury and the reported clinical findings on site. During the secondary survey including the whole body CT scan the contiguous spine fractures were diagnosed. Fractures at the thoracolumbar junction are typical after a fall from great height. The involvements of three adjacent vertebrae can be regarded as a sign of high local energy impact (Figs. 1, 2). The Th12 and L1 fractures were compression fractures and considered stable (Magerl Type A1.2). The L2 burst fracture on the other hand had almost complete canal occlusion and had an additional disruption of the posterior elements (Type B2.3). Because of the severe neurologic deficit and the unstable nature of the fracture the patient was treated with instant fracture reduction and posterior pedicle screw instrumentation from Th12 to L3. This initial plan of treatment can be judged as appropriate as shown by the complete neurologic recovery. An anterior approach to the spine would have increased this multiply injured patient's morbidity, so that the rationale for damage

controlled spine surgery as it was done seems appropriate. According to the ATLS® guidelines prolonged operations should be avoided in the acute phase after a life-threatening injury. In the present case the Injury Severity Score (ISS) added up to 27, giving favour to the posterior procedure rather than a combined or anterior approach, both of which are associated with a higher morbidity [2].

However, no postoperative CT scan of the fracture was done to assess the need for an anterior column reconstruction. In complete burst fractures many authors recommend a 360° reconstruction, which can be realised in two separate sessions. One advantage of the 360° reconstruction is the high fusion rate, which has been reported to reach 97% [1]. Another argument supporting a combined approach is the low rate in loss of reduction compared to a posterior or anterior approach alone [7]. In addition, biomechanical studies showed the improved balance and thus physiological load distribution and regarding the anterior and posterior column [8].

Rationale for second surgery

When the patient complained about recurrent back pain and radicular pain 1 year postoperatively, X-rays clearly showed a loss of reduction. In the MRI scan, severe spinal stenosis at the level of L2 was evident. As a primary postoperative CT or MRI scan had not been performed it may be suspected that there was a persistent stenosis, which later became clinically evident with the loss of reduction. The first revision was a combined posterior and

Fig. 7 MRI scan showing myelon oedema at the level Th10/11

anterior reconstruction aimed at reconstruction of physiological load sharing. As the Th12 and L1 fractures were considered to be consolidated, the posterior instrumentation was decided to stop cranially at L1. Unfortunately, the reinstrumentation of the formerly fractured first lumbar vertebra resulted in a necrosis of the vertebral body. Whether a longer instrumentation would have been advantageous remains debatable.

Rationale for third surgery

One year later when the first revision had failed it was thought that by extending the posterior and anterior fixation we would achieve a biomechanically more stable situation. To avoid a stress concentration at the cranial adjacent level, the posterior instrumentation was extended to Th11 to aim for a better load distribution. Anteriorly, the formerly fractured first and second vertebra were resected and replaced by a long mesh cage (Harms-cage) that was thought to be more “biologic” with more room

Fig. 8 Gas formations ventral to the spine indicating the deep infection

for bone grafting than a bulky expandable cage. An additional anterior rod stabilisation from Th12 to L3 was performed. Unfortunately, this procedure was followed by progressive incomplete paraparesis starting 3 h postoperatively. The late onset of the paraplegia makes a direct surgical damage of the spinal cord unlikely. The working hypotheses in this event were either an epidural haematoma or an ischaemic event to the spinal cord. The diagnostic tool of choice to rule out any spinal cord compression was an MRI scan, which demonstrated an oedema of the spinal cord at the level Th10/11 and the absence of epidural haematoma. The patient was therefore thought to have an anterior spinal artery syndrome. Plausible explanations could be represented by an insult to the Adamkiewicz artery during correction manoeuvre. As the cause was assumed to be an ischaemia, treatment consisted of anticoagulation with heparin and hemodilution using HES.

Rationale for subsequent radical debridement operation

Six months after her second revision the patient presented with a deep wound infection that had persisted despite several consecutive irrigation debridements. Infection is a rare complication after orthopaedic spinal operations. In their recent retrospective case–control study, Olsen et al. [4] identified an overall infection rate of 2.0% (46 of 2,316). However, the risk of infections rises with the

Fig. 9 CT 5 weeks and radiograph 2.5 years after the last revision documenting correct implant positioning and physiological spinal profile

number of surgical procedures. Those infections sometimes require explantation of hardware and thorough debridement plus long-term antibiotic therapy. In this case the anterior cage and anterior rod instrumentation were completely exchanged. According to the recommendations for the treatment of spondylodiscitis the patient received antibiotics for 12 weeks postoperatively.

Procedures

- 1/14/2001: Posterior instrumentation Th12–L3 in an external facility (TenorTM system, Sofamor Danek[®], Inc.)
- 3/21/2002: Revision with combined approach—posterior and anterior instrumentation L1–3, right-sided hemilaminectomy, decompressive partial corpectomy of L2, vertebral body replacement by an expandable cage (USSTM, VentroFixTM, SynexTM, Synthes[®], Inc.)
- 10/17/2002: Second revision using a combined approach—posterior instrumentation Th11–L3 (ExpediumTM, DePuy Spine[®], Inc.), anterior support with partial corpectomy of L1, total corpectomy of L2 and replacement by a long Harms-cage
- 5–6/2003: Several local debridements in an outside facility with drainage of psoas abscess
- 6/23/2003: Revision with an anterior approach: Debridement involving partial corpectomy of Th12, vertebral

body replacement by a custom-made Harms-cage (DePuy Spine[®], Inc.) filled with Refobacin[®] bone cement (Biomet[®], Inc.).

Procedure imaging section (Figs. 4, 5, 6, 7, 8, 9)

Outcome

In combination with long-term antibiotics the final revision led to a quick regression of infectious laboratory parameters and clinical recovery. Medical exams, laboratory results and radiological follow-up until 1 year postoperatively were uneventful and without any further problems.

At last follow up after 2.5 years postoperatively the patient demonstrated a remaining but partially recovered paraparesis. At this time she was ambulating with crutches and was highly motivated for further rehabilitation. Back pain was not mentioned. There were no signs of recurrent infection. X-ray showed a physiological spinal profile and correct implant positioning without signs of implant loosening.

References

1. Gertzbein SD, Betz R, Clements D, Errico T, Hammerberg K, Robbins S, Shepherd E, Weber A, Kerina M, Albin J, Wolk D

- (1996) Semirigid instrumentation in the management of lumbar spine conditions combined with circumferential fusion. A multi-center study. *Spine* 21:1918–1926
2. Heyde CE, Ertel W, Kayser R (2005) Die Versorgung von Wirbelsäulenverletzungen beim Polytrauma. *Orthopäde* 34:889–905
 3. Knop C, Blauth M, Bastian L, Lange U, Kesting J, Tscherne H (1997) Frakturen der thorakolumbalen Wirbelsäule. *Unfallchirurg* 100:630–639
 4. Olsen MA, Nepple JJ, Riew KD, Lenke LG, Bridwell KH, Mayfield J, Fraser VJ (2008) Risk factors for surgical site infection following orthopaedic spinal operations. *J Bone Joint Surg Am* 90(1):62–69
 5. Roy-Camille R, Saillant G, Gagna G, Mazel C (1985) Transverse fracture of the upper sacrum. Suicidal jumper's fracture. *Spine* 10(9):838–845
 6. Ruchholtz S, Nast-Kolb D, Waydhas C, Schweiberer L (1996) Das Verletzungsmuster beim Polytrauma. *Unfallchirurg* 99:633–641
 7. Stoltze D, Harms J (1998) Kombinierte Stabilisationsverfahren an der thorakolumbalen Wirbelsäule. *Osteosynth Intern* 6:157–171
 8. White AA, Panjabi MM (1990) *Clinical biomechanics of the spine*, 2nd edn. Lippincott-Raven, Philadelphia