New Treatment Resources of Traumatic Thoracolumbar Burst Fractures – Minimally Invasive Open Anterior Column Reconstruction: our Initial Experience

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Summary

**Introduction.** Thoracolumbar burst fracture is a common pathology in spinal trauma surgery. Most important for the understanding and treatment spinal injuries is to recognize spinal stability or instability as for unstable injuries stabilisation is recommended. Posterior only stabilisation leads to a high incidence of implant failure and re-kyphosis in the long-term, and patients with implant failure have moderate-to-severe pain. 80–85% of axial forces on the spine are transmitted via the anterior vertebral column. The aim of the procedure is to restore anatomical alignment and integrity to unstable or destroyed segments of the anterior column of the thoracic and lumbar spine. An open minimally invasive surgical approach is used to minimise surgical trauma and to reduce perioperative and postoperative morbidity.

**Aim of the Study.** We analyzed our initial experience in spinal anterior column stabilization for thoracolumbar burst fractures.

**Materials and methods.** We have reviewed first 37 patients with thoracolumbar burst fracture who have undergone anterior column stabilization in the Department of Spine Surgery of Trauma and Orthopaedic hospital between September 2007–September 2010.

**Results.** We initially reported a series of 37 consecutive patients (14 women, 23 men) who were treated with minimally invasive open anterior column stabilization in the thoracic and lumbar spine. An open minimally invasive surgical approach is used to minimize surgical trauma and to reduce perioperative and postoperative morbidity.

**Conclusions.** Our initial experience encourages us to continue this type of operation as it proved to be safe for patients, the stability of the spine is much higher and anterior column stabilisation protects the spine.

**Key words:** thoracolumbar burst fracture, anterior column stabilisation, minimally invasive surgical approach.

INTRODUCTION

Thoracolumbar burst fracture is a common pathology in spinal trauma surgery. Usually this is a high-energy trauma when compression, distraction or rotation load through the spine causes the vertebra to break or shatter into many tiny pieces and damage the ligaments and discs which stabilize spine. Burst fractures are most often caused by car accidents or falls. Management of the burst fracture without neurologic deficit is still more controversial. The danger of these fractures is that the bone fragments can shift and press into the spinal cord and another problem is the collapse of the anterior portion of the spine results in a kyphotic deformity. Most important for the understanding and treatment of spinal injuries is to recognize of spinal stability or instability as for unstable injuries stabilisation is recommended. Sometimes it is difficult to recognize stability, because vertebral spine injuries are very heterogeneous in nature—no absolutely similar fracture, no strict definition of instability and difficult to verify ligamental injury, but ligaments are important stabilizing structures. Many authors offer many ways to treat thoracolumbar burst fractures:

1. **Only posterior approach**
   - Short segment posterior fixation (SSPF) (four screws: one level above and below the fracture)
   - Long segment posterior fixation (LSPF) (eight screws: two levels above and below the fracture)

2. **Only anterior approach**
   - Allo or autobone substitution
   - Allo or autobone substitution plus plate
   - Mesh cage plus anterior plate or screw and rod system
AIM OF THE STUDY

We analyzed our initial experience and significance of spinal anterior column stabilization with different implants and different methods for thoracolumbar burst fractures.

MATERIALS AND METHODS

We have reviewed first 37 patients with thoracolumbar burst fracture which have undergone anterior column stabilization in the Department of Spine Surgery of Trauma and Orthopaedic hospital between September 2007–September 2010. We analyzed patient data, operating techniques, perioperative outcomes, different implants for anterior column stabilization and early follow-up data.

For vertebral body replacement we used the following systems (Fig. 1): Tricortical iliac crest bone alone, Tricortical iliac crest bone plus locking compression plate (Synthes), Tricortical iliac crest bone plus screw and rod system (Expeditum anterior (DePuy)), Expandable cage (Synex (Synthes)), Expandable cage (Obelisc (Ulrich)), Nonexpandable meshed titanium cage (DePuy).

Computed tomography (CT) scans and standard X-ray were done preoperatively to classify the fracture type. Traumatic injuries to the spine were categorized according to Magerle's classification (8). A fracture severity score was constructed using the LSC (load sharing classification) described by McCormack et al. (9) to compare fracture severity. Changes in the anterior vertebral height ratio, vertebral wedge angle, upper intervertebral angle, lower intervertebral angle, Cobb4 angle (13), regional angle, and sagittal index were measured preoperatively, postoperatively, final follow-up. The postoperative functional outcomes were evaluated using Roland–Morris disability questionnaire (RMDQ–24) together with the Visual Analogue scale (VAS) spine score (17). Neurologic assessment was done using the grading scale of Frankel et al. (4).

Surgical technique

For thoracotomy higher than TH9 intubation with single lung ventilation was selected. The patient is placed in a stable lateral position on the right side and fixed with a two point support at the sacrum and scapula, as well as with arm rests.

For the treatment of fractures from T4 to T8, a leftsided position is preferred. The decision of which side to choose for access is taken in each individual case based on the preoperative CT scans of the spinal section and the vascular situation of the aorta and the vena cava they show. The target area is projected onto the skin level under fluoroscopic control and the borders of the fractured vertebra are marked on the skin. A 8–10 cm skin incision is then made and is followed by dissection of the three layers of the abdominal wall along their fibres until the retroperitoneal space is reached after penetrating the transversus abdominis fascia and muscle.

For wider exposure but smaller incision in minitoracotomy we can use “sliding” technique. This is another alternative which gives sufficient monosegmental exposure without rib defect. Only one osteotomy is performed and when spreading the intercostal space, one rib “slides” over the other to give a wider exposure as compared to an intercostal approach. After opening the thoracic cavity the lung is identified. The retractors are placed. The procedure is based on the use of a table–fixed retractor system (SynFrame) and is performed with specially manufactured elongated surgical instruments that are operated from outside of the patient’s body (17). After exposing the spine laterally, the level of the affected vertebra is identified with the image intensifier and the adjacent disc spaces are marked with long needles (Fig. 2). The location of the anterior longitudinal ligament and spinal canal can be calculated from the position of the needles. In most cases the overlying segmental vessels of the affected vertebra need to be clipped or coagulated. The vertebral discs are cut first, following that the fractured vertebrae are removed and vertebral prosthesis or allograft inserted (Fig. 3). The thoracic cavity is irrigated, blood clots are removed, and a chest tube is inserted with the end placed in the costodiaphragmatic recess for 24–48 h or when fluid is less than 100 ml.

RESULTS

We initially reported a series of 37 consecutive patients (14 women, 23 men) who were treated with minimally invasive open surgery to the anterior column between September 2007 and September 2010. In 5 patients in our first series surgery was performed for treatment or correction of posttraumatic kyphosis or a nonunion of thoracolumbar fractures. The remaining 32 patients...
had traumatic „fresh” injuries. Of these, 30 patients had isolated spine injuries whereas 8 patients had additional (sometimes multiple) injuries to the head (n = 1), thorax (n = 3), pelvis (n = 1) and extremities (n = 3). Mean age was 39 (range: 16–58). There were 25 cases of fall injuries from height, 10 cases of traffic accident injuries and 2 patients had direct trauma. Twenty two patients had type A, twelve had type B and 3 had type C fractures. There were 5 fractures of the thoracic spine (T4–10), 17 fractures involving the thoracolumbar junction (T11–L1) and 15 fractures of the lumbar spine (L2–4). The most affected level was L1 (11 patients). 5 patients after thoracotomy developed postoperative pneumonia, but it resolved within 10 days after conservative (physiotherapy and appropriate antibacterial) treatment. 2 patients needed bronchoscopy for lung collapse. 2 patients needed pleural puncture after chest tube removal, because of hydrothorax.

Neurologic assessment was done using the grading scale of Frankel et al. 8 of these patients presented with a neurologically deficit – 4 patients with lower paraplegia, 4 patients with urinary bladder dysfunction which decreased after spinal canal decompression. No postoperative complications such as hernias or paresis of the diaphragm were recorded (partial incision at the attachment of the diaphragm was needed for approach to level L1).

The time from injury to anterior column surgery varied from 10 days to 10 weeks (average 4 weeks after trauma and 10 days after posterior stabilisation).

Out of the 37 patients, 29 had stabilisation with a posterior SSE System (Aesculap, Braun) prior to the anterior spine surgery. In 5 cases anterior and posterior surgery were performed in one day. In 4 patients a right-sided mini–thoracotomy and 1 left sided minithoracotomy was performed to access the midthoracic spine (T4–8), a left–sided mini–thoracotomy to reach the thoracolumbar junction (T9–L1) was used in 14 patients and a retroperitoneal minilateral approach was used in 18 patients for lumbar spine intervention (L2–L4). Spinal clearance was performed in 6 patients via anterior mini–thoracotomy (n=4) or retroperitoneal approaches (n=2). Allogeneic iliac crest bone was harvested in 11 patients and iliac crest autografts in 1 patient. Expandable (Synex) cages were used for vertebral reconstruction in 9 patients, expandable (Odelisc) cage were used in 8 patients, nonexpandable mesh cage (DePuy) were used in 2 cases, tricortical iliac crest bone plus screw and rod system (Expedium anterior (DePuy)) – in 12 patients. Tricortical iliac crest bone or expandable cage plus locking compression plate (Synthes) in 3 patients. The cages were filled with spongiosa from the corporectomy and in 3 patients additional allognionga was harvested from the alloiliac crest or femoral neck and for 2 patients additional calcium phosphate granules were needed for bone matrix. The operating time (OT) from incision to closure was recorded. It must be emphasized that this time included the learning period of using this technique. The mean OT was 190 min (range 80–275 min) but this varied depending on the magnitude of the intervention. An additional 45 min were needed in cases that required spinal clearance. No complications related to the minimal access technique and neither visceral or vascular injuries were observed. In 7 patients we used intraoperative placement of intercostal catheter for postthoracotomy pain relief. No patients developed intercostal neuralgia or post–thoracotomy pain syndromes. Most patients reported mild pain at the site of intervention but in all cases this resolved completely after several days.

No postoperative wound infections or deep venous thrombosis were recorded. After anterior column surgery patients with isolated spinal pathology were discharged from hospital after average 13 days (range: 7–30 days). The mean blood loss was 410 ml (range 150–1000 ml). The subgroup requiring spinal clearance (n = 5) had a greater mean blood loss of 650 ml. The skin incision for mini–thoracotomy or retroperitoneal approaches was average 9 cm long (Fig.4). Such small incision are possible because we used rib osteotomy and retractor system (SynFrame) and microscope or light sources. The minimum follow – up period was 2 weeks and maximum 3 years. In 1 case after anterior column surgery with allobone substitution alone nonunion and breaking of hardwear was observed, but patient had non significant complaint. In 2 cases 3 months after anterior reconstruction using expandable cage distal cage part migration through endplate 2–3mm was observed. No significant loss of correction was found.

**DISCUSSION**

Selection of the surgical method in the treatment of thoracolumbar burst fractures always remains a matter of discussion. Short segment posterior fixation is frequently regarded as the procedure of choice because it offers advantages. But without body reconstruction this method has a 9–54% incidence of implant failure and re–kyphosis (1). To prevent this, several techniques have been developed to augment the anterior column in burst fractures. One of choice is transpedicular bone grafts in addition to short segment posterior fixation (1). Many authors believe that transpedicular bone grafts have not prevented early implant failure and correction loss, and may lead to low anterior interbody fusion rates in the long term (6, 7). Anterior column restoration has proven to be effective, but requires a more invasive approach, prolonged op.time, more blood loss and more complications (11,13,14). Minithoracotomy or lumbotomy significantly decreases complication risk and postoperative pain after anterior spine reconstruction.

Inserting the screws only one level above and below the fractured segment might not provide adequate stability. Gurr et al. (5) found that two levels above and below the injured level in an unstable calf spine model provided more stiffness than the intact spine. Carl et al. (2) reported that segmental pedicular fixation two levels above the kyphosis should be used at the thoracolumbar junction, where compression forces act more anteriorly. In contrast, in the more lordotic middle and lower
lumbar spine, where the compressive forces act more posteriorly, no implant failures occurred with the one above, one below construct. Use of four pairs of screws (two above and two below) to lengthen the level arm of the construct would probably not only have enhanced the stability but also allowed effective reduction of kyphotic deformity (5).

The thoracolumbar junction constitutes the transition zone between the rigid thoracic and the mobile lumbar spine. Vertebral fractures in this area are usually extremely unstable and kyphotic deformity is often of significant degree (19, 9).

Previous studies revealed that high incidence of instrumentation failure and loss of kyphotic correction after SSPI are caused mainly by the structural and mechanical deficiency of the anterior column after indirect reduction of the fracture (18). The biomechanics of long versus short fixation for thoracolumbar spine fractures saving motion segments by limiting the number of the fusion segments has been seen as a fundamental principle of spinal surgery (21).

Bone grafting and single ventral instrumentation has been shown to be more effective in restoring acute stability than single dorsal instrumentation (20).

CONCLUSIONS

Our initial experience encourages us to continue this type of operation as it proved to be safe for patients, the stability of the spine is much higher and anterior column stabilization protects the spine. The surgical goals for anterior spinal stabilization are decompression of the spinal canal, reduction of spinal deformities, maintenance of stable fixation of the spine to permit early mobilization and prevent kyphotic deformity. The early studies show that patients after combined – anterior and posterior stabilization after thoracolumbar burst fractures feel much more stable and safer than after dorsal stabilization alone.

The small incisions with reduced soft tissue dissection reduce postoperative pain, hospital stay, costs and improve cosmetic and functional results. Further follow up of more patients and a longer observation period is necessary to find more reliable information for evaluating long-term results. In our experience this procedure is associated with reduced blood loss, shorter hospital stay and less perioperative morbidity than conventional open spine surgery.

Conflict of interest: None

REFERENCES


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Fig. 4. Skin incision for anterior approach to the L1

Fig. 5. Case example: Compression fracture type A 3.3 with spinal canal compromise and kyphotic deformity

Fig. 6. Case example: Primary dorsal reduction and fixation with laminectomy

Fig. 7. Case example: Primary dorsal reduction and fixation followed by minitoracotomy and anterior decompression and reconstruction using expandable cage Synex

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