Posterolateral Debridment and Anterior Reconstruction By Limited Spinal Shortening In Spinal Infections

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1 Introduction

In severe osteomyelitis of the spine, open debridement and anterior fusion by anterior bone grafting offers the advantage of eradication of the focus of infection and improvement of conditions for bony fusion of the affected vertebral bodies (Benli et al. 1997, Dai et al. 2005, Korovessis et al. 2006, Krodel et al. 1999). In last few years a shift occurred in the preferred surgical approach for management of thoracic and lumbar spinal infections with a lot of research works reported good results with posterior surgical approach (Abdel-Wanis 2006, Abdel-Wanis 2012, Chanplakorn et al. 2011, El-Sharkawi & Said 2011, Guzey et al. 2005, Zhang et al. 2012). In 2006, I reported the results of 12 patients of spinal infections of the thoracic and lumbar spine treated through a single posterior circumspinal exposure (Abdel-Wanis 2006). El-Sharkawi and Said compared the results of one stage circumferential fusion and anterior debridement and fusion followed 10-14 days later by posterior stabilization and posterolateral fusion for treatment of dorsolumbar spine tuberculosis. They reported that one-stage surgery is advantageous because it has a lower complication rate, shorter hospital stay, less operative time and blood loss (El-Sharkawi & Said 2011). Zhang et al. retrospectively reviewed 36 cases of thoracic spinal tuberculosis treated by two different surgical procedures: 20 cases in Group A underwent single-stage posterior debridement, transforaminal fusion and instrumentation, and 16 cases in Group B underwent posterior instrumentation, anterior debridement and bone graft in a single- or two-stage procedure. They concluded that the posterior approach only procedure obtained better clinical outcomes than combined posterior and anterior surgeries. They considered that single-stage posterior debridment is a better surgical treatment for thoracic spinal tuberculosis in aged patients with poor health status, especially for cases in early phase of bone destruction and/or mild and moderate kyphosis (Zhang et al. 2012).


The first case of use of limited spinal shortening for anterior spinal reconstruction in spinal infection was reported by the current author in 2006. The paper published was entitled “Single-stage posterior circumspinal debridment and reconstruction for thoracic and lumbar spinal infections”. In this work I reported on 12 patients, 5 of whom received spinal shortening for anterior reconstruction of the spine (Abdel-Wanis 2006). In 2011, I reported 10 patients of infections of the thoracic spine treated by single posterolateral exposure and the anterior reconstruction was achieved in all patients by spinal shortening (Abdel-Wnis 2011, Abdel-Wanis 2012). Also, in 2011, Chanplakorn et al. reported treatment of 3 patients with acute tuberculous spondylitis by spinal shortening osteotomy (Chanplakorn et al. 2011).


2 My Technique

Patients are operated under general anesthesia in the prone position through a single posterior exposure. No intraoperative neuromonitoring was used during the operation. The incision is a straight vertical midline incision extended for one level above and below the planed instrumentation levels. The paraspinal muscles are dissected and laterally retracted. Lateral dissection is performed till the tip of the transvers process in the lumbar spine and about 5 cm of the rib is exposed in the thoracic spine. Posterior stabilization by trans-pedicular screw fixation is performed usually for one level above and one level below the affected vertebra. A rod is inserted in one side (usually the right side) while the rod in the other side is not inserted to give space sufficient for laminectomy and anterior dissection. Laminectomy is carried out. For full exposure of the anterior aspect of the vertebral bodies, excision of the medial 5 cms of one or two ribs is performed in one side (Figure 1 A). We prefer anterior circums spinal dissection on the left side because the wall of the aorta is strong and resistant to injury by the blunt dissection contrary to the wall of the vena cava that might be injured easily. The intercostal artery and nerve are ligated and divided. The stump of the intercostal nerve is used for gentle indirect manipulation of the spinal cord. Blunt anterior dissection using the finger and gauze is carried out. Then, spatual-originally developed for posterior total en bloc spondylectomy operation by Tomita (Abdel-Wanis et al. 2002, Murakami et al. 2001, Tomita et al. 1994, Tomita et al. 1997) – is then inserted anterior to the vertebral body or bodies (Figure 1 B). In the lumbar spine, dissection around the vertebral body is not needed as retraction of the cauda equine usually gives good space sufficient for curettage of the disc and debridment of the infected tissues and the technique should be a modification of posterior lumbar interbody fusion (PLIF) (Lee & Suh 2006). Also, in the thoracic spine, when there is no much debris or pus to be evacuated lying anterior to the vertebral column, curettage of the disc infection might be possible from the space available lateral to the spinal cord. Then, reconstruction of the anterior column is performed by limited spinal shortening. Care must be given during shortening to avoid kinking of the cord or compression on the nerve roots by the pedicles. Then, posterior fusion is performed. Bone graft used is local graft from the ribs and laminae (Figure 1 C). Postoperatively, a brace is used during walking or sitting for 3 months. Patients were followed up by monthly radiographs.

3 Results of the Technique

I treated 10 patients with infection of the thoracic spine (Figure 2) and 22 patients of infections of lumbar spine by this technique (Figure 3). Causative organisms were TB in 20 patients, Staph aureus in 4 patient, salamonella typhi 1 patient, brucella in 1 patient and bacteriologic testing of intraoperative samples did not find germs in 6 patients. Operative time ranged between 100-190 (mean 135) minutes for thoracic spine operations, and between 110-180 minutes for the lumbar spine operations. For thoracic spine infections, local kyphosis angle ranged between 0 ° to 40 ° and (mean 17.5°), while post-operatively ranged between 0° and 19° (mean 10.9°). For the lumbar spine infections preoperative local lordotic angle ranged between 30° to -10° (mean 2.5°), improved post-operatively to a mean of 10.04° (range; 35° to -10°) (lordotic angle is expressed as + while kyphotic angle is expressed as -). Only3 patients received antibiotic medication pre-operatively; one caused by brucella and 2 caused by pyogenic infections. However, in the 3 patients as there was no response for full course of antibiotics, surgery was indicated.
Figure 1: Technique (A) Posterior stabilization by trans-pedicular screw fixation is performed for one level above and one level below the affected vertebra. A rod is inserted in the right side. Laminectomy is carried out. Then, excision of the medial 5 cms of one or two ribs is performed in one side. We prefer anterior circumspinal dissection on the left side (B) Blount anterior dissection using the finger and gauze is carried out. Ligation of the intercostal nerve and artery is done. Then, a spatula is inserted anterior to the vertebral. The space developed is sufficient for evacuation of the abscess and curettage of the lesion. (C) Left-side rod is inserted. Anterior reconstruction is achieved by spinal shortening and local bone graft obtained from the laminae and ribs is used for achieving posterior spinal fusion.
Figure 2: Male patient 50 years old presented with spasticity of both lower limbs although the motor power of muscles were normal. The patient had liver impairment due to infection by hepatitis C virus. A and B: Plain radiographs of the thoracic spine showing destruction of Th7 and 8 including the intervertebral disc C: MRI sagittal T1-weighted image and D: MRI sagittal T2-weighted image showing severe destruction with abscess formation and compression on the spinal cord at the level of Th7-8. E: MRI axial T2-weighted image at the level of Th7-8 disc and F: MRI gadolinium enhanced axial image at the level of Th7-8 disc showing big paraspinal abscess and spinal cord compression. G and H: Post-operative plain radiographs showing instrumentation to the pedicles of Th 6 and 9 vertebrae with anterior reconstruction achieved by spinal shortening and the lower border of Th7 comes to contact to the upper border of Th8.
Figure 3: Male patient -69 years old- presented with agonizing low back pain and rapid neurological deterioration (Frankel grade C). (A) and (B): pre-operative sagittal MRI T2- weighted image of the lumbar spine showing the abscess and neural compression. The patient was treated by PLIF with anterior reconstruction achieved by spinal shortening. Specimen obtained during the operation showed no growth of micro-organisms on the culture media. (C) and (D): plain AP and lateral radiographs 1 year post-operative showing good bone healing of the affected level. The patient was followed up for 72 months with no reactivation of infection or occurrence of any complication.

Five complications were encountered; mal-positioned pedicle screw, deep venous thrombosis (DVT), delayed wound healing, kyphosis progression and temporary neurological deterioration. No active infection occurred tell the end of follow up. The temporary neurological dysfunction was related to malpositioned screw inside the thoracic spinal canal and was discovered intra-operative. The screw was repositioned inside the corresponding pedicle. However, post-operatively there was clear neurological deterioration from Frankel grade D to Frankel grade C. The patient got full neurological recovery to Frankel grade E within 3 months.

4 Advantages

In my opinion and based in my experience in management of my patients, the posterolateral exposure of the spine used as a sole approach has a lot of advantages over the anterior exposure in treatment of infec-
tions of the spine. It carries less morbidity, spine surgeons are more familiar with the posterior exposure than the anterior one (Saita et al. 2005), it gives access to both the vertebral body and neural arch and for multiple levels, it gives access to all levels from the first thoracic to fifth lumbar vertebrae and complications are less serious. It does not present risks to the chest or abdomen, which might induce serious hazards for extremely elder patients (Saita et al. 2005). Another main advantage of posterior spinal exposure is that the spinal cord or the cauda equina is always under surgeon’s vision during debridment and reconstruction. This is contrary to the situation in case of anterior spinal debridment because the dura lies behind the vertebral body. If dural tear to complicate anterior debridment, dural reconstruction through the anterior exposure is extremely difficult. Reconstruction of the anterior column by limited spinal shortening, has a lot of advantages; avoiding the complications of bone graft harvesting and insertion. The operative time is short. A very wide anterior cancellous bone contact can be achieved so that the stability of the construct is high, so that early mobilization can be allowed with remote possibility of failure of instrumentation or dislodgment of anterior cage or bone graft.

5 Risks

For sure there are some risks that must be noted and avoided.

5.1 Neurological Deficit

The great concern in this technique is neurological deficit that might occur as a result of 4 causes: excessive shortening causing kinking of the cord or cauda equina, anterior compression of the spinal cord by any bone fragment or debris pushed into the spinal canal during spinal shortening, kinking of the nerve root in its canal or impingement on the nerve root by the pedicle.

It is clear that the safety of spinal shortening might depend on the spinal level of shortening. The safe range of spinal shortening might be more at the cauda equina levels than at the spinal cord level. This may be related to the fact that the nerves in the cauda equina may be capable of responding to spinal shortening by increasing their redundancy. In an experimental study morphometric changes of the spinal cord and dura, influence on spinal cord evoked potentials (SCEPs) and spinal cord blood flow (SCBF) and postoperative function of hind limbs were studied in various degrees of acute spinal column shortening in dogs. Total spondylectomy of T13 was performed in dogs after spinal instrumentation placed 2 levels above and 2 levels below the spondylectomy level. Spinal column was gradually shortened until the lower endplate of T12 contacted the L1 upper endplate (maximum of 20 mm) come into contact. No morphometric changes occurred in the dural sac and the spinal cord until shortening of 7.2±1.7 mm. From 7.2±1.7 to 12.5±1.1 mm shortening, the dural sac was deformed while the spinal cord maintained its shape. Shortening more than 12.5±1.1 mm buckled the dural sac and the spinal cord was kinked itself and compressed by the buckled dura in its concave side. No changes could be detected in SCEPs in 5 or 10 mm of shortening. SCEPs changes were recorded in the 2 of 6 dogs with 15 mm of shortening. At 20 mm of shortening, SCEPs abnormality was observed in 4 of 6 dogs. At shortening of 5, 10, 15 and 20 mm, spinal cord blood flow was 146±10 %, 160±21 %, 102±17 % and 93±7 % of the control (29.2±7.9 ml/100g/min), respectively. All 3 dogs with 10 mm of shortening had normal hind limbs function after operation. One of the 3 dogs with 15 mm of shortening had paraparesis. Three of the 4 dogs with 20 mm of shortening had also paraparesis after operation. From this work it was concluded that acute spinal column shortening can be characterized into three phases: Phase 1; safe range: occurred during shortening...
within one-third of the vertebral segment and is characterized by no deformity of the dural sac or the spinal cord. Phase 2; warning range: occurs during spinal shortening between one and two-thirds of the vertebral segment and is characterized by shrinking and buckling of the dural sac and no deformity of the spinal cord. Phase 3; dangerous range: occurred after shortening in excess of two-thirds of the vertebral segment and is characterized by spinal cord deformity and compression by the buckled dura. Spinal shortening within the safe range increases spinal cord blood flow (Kawahara et al. 2005).

Other experimental paper was published by Alemdaroğlu et al. (2007) and described the mechanism of the sliding and kinking of the cord due to gradual shortening of the spine. Total vertebrectomy of T12 was applied to ten sheep models after spinal instrumentation. Measurements were taken at different laminectomy lengths to record kinking of the spinal cord with gradual shortening. The mean sliding of the spinal cord was 9 mm cranially and 7.8 mm caudally. T11 spinal nerves became more vertical caudally, and T12 spinal nerves achieved an ascending position with gradual shortening. Both T11 and T12 spinal nerves were sharply bent in the foramen and on the pedicle of T13, respectively. In full-length shortening, the mean kink of the spine in the sagittal plane was 92.4° for two levels of hemi-laminectomies, 24.6° for complete laminectomy of T11 with hemilaminectomy of T13, and 20.2° for two levels of complete laminectomies. Increasing the laminectomy length by only a half or one level prevents excessive kinking and compressions at the upper and lower margins of the laminectomy. In the later stages of shortening, the spinal nerves near the vertebrectomy site are at risk because of the sharp bending of the nerves. This study concluded that it is possible to avoid excessive kinking by planning the appropriate technique of laminectomy style in full-length shortening.

To avoid neurological complications, we insist on the following points:

a- Shortening in the thoracic spine must be limited to one third of the height of one vertebra.

b- Spinal cord must be carefully observed during shortening to avoid kinking. If kinking is noticed, release the shortening, widen the laminectomy and then re-shorten the spine.

c- The anterior aspect of the cord must be carefully examined after achieving full shortening to be sure that there is no anterior compression to the cord.

d- The whole course of the nerve roots tell neural foramen must be checked after achieving full shortening to ensure no kinking or compression on the root by the pedicle of the upper vertebra.

5.2 Scarification of Motion Segments

Posterior surgery for spinal infections might be criticized by causing loss of motion segments more than the anterior surgery. Lee and Suh reported on 18 patients with lumbar spine pyogenic infection treated by PLIF with an autogenous iliac crest bone graft. They considered that the main disadvantage of PLIF in comparison with anterior debridment is the need for fixation of one, two or more segments when vertebral body destruction is severe (Lee and Suh 2006). In general, our policy in the lumbar spine infection was that transpedicular screws be placed in the upper part of the infected vertebral body if it is not massively destroyed by infection. This would decrease the extent of fixation and help us to save motion segments in cases with limited vertebral body destruction (Figure 3). This advantage may be lost in cases with severe vertebral body destruction where multiple motion segments must be immobilized. In 16 out of 22 patients of lumbar spine infection (73%) insertion of the pedicle screws was in the affected vertebrae with one level fusion. In 6 patients (27%), we sacrificed an additional single monition segment.
5.3 Possibility of Reactivation of Infection

The subject of using metallic implants in the setting of spinal infection remains controversial, although more and more surgeons acknowledge that instrumentation can help the body to combat the infection rather than to interfere with it. The combination of radical debridement and instrumentation has lots of merits such as, restoration and maintenance of the sagittal alignment of the spine, stabilization of the spinal column and reduction of bed rest period (Chen et al. 2007). Korovessis et al. reported 14 patients with thoracolumbar spondylitis treated with anterior surgery with insertion of titanium mesh cage and posterior instrumented fusion. Most patients had also systemic diseases as lung tuberculosis, hepatic cirrhosis, diabetes mellitus, or chronic renal failure. There was one complication, an anterior wound abscess culminating in an abdominal hernia. They concluded that the presence of the mesh cage anteriorly at the site of spondylitis had no negative influence on the course of infection healing, and additionally it stabilized the affected segment maintaining sufficient sagittal profile (Korovessis et al. 2006). Other authors reported safety of instrumentation in spinal infections (Masuda et al. 2006, Rayes et al. 2010). I have the same experience in my patients. Among 32 patients treated by my technique, I did not get any case of activation of infection.

5.4 Injury to the Anteriorly Located Blood Vessels

In our technique, there is a possibility to injure the aorta or the vena cava while performing circumspinal dissection for anterior debridment. We prefer dissection from the left side because the wall of the aorta is strong and might not be injured by blunt dissection. Dissection in the right side is better to be avoided unless highly indicated because the wall of the vena cavae is thin and liable to injury. Insertion of the spatula anterior to the vertebral body actually adds more protection to the anteriorly located anatomical structures. In all of my patients, no injury of anterior structures was encountered.

References


