ABSTRACT

Purpose. To evaluate treatment outcome of tension band wiring followed by posterior spinal fusion and instrumentation for thoracolumbar flexion-distraction injury (FDI).

Methods. 36 men and 12 women aged 21 to 56 (mean, 36) years underwent tension band wiring followed by posterior spinal fusion and instrumentation using pedicular screws for FDI of the thoracolumbar spine. The injured vertebral levels were T11 (n=2), T12 (n=12), T11-T12 (n=1), T12-L1 (n=1), L1 (n=28), and L2 (n=4). Anterior vertebral body height and kyphosis were measured before and after surgery. Neurologic status was assessed using the American Spinal Injury Association (ASIA) scale. The Oswestry Disability Index questionnaire and visual analogue scale for pain were also used.

Results. The mean follow-up was 38 (range, 26–72) months. At final follow-up, the mean visual analogue scale for pain was 1.7, and the median Oswestry Disability Index was 4% (range, 0–32%). The mean anterior vertebral body height improved from 20.5 to 38.8 mm (p<0.001). The mean kyphosis improved from 20.4º to 1.5º (p<0.001). Four patients had persistent neurologic deficit: ASIA scale C (n=2) and D (n=2); their ASIA scales improved by one grade. All patients returned to their original work at 6 months. There were no intra-operative complications or implant failures.

Conclusion. Posterior tension band wiring followed by posterior spinal fusion and instrumentation for thoracolumbar FDIs achieved good outcome.

Key words: spinal fusion; spinal injuries

INTRODUCTION

43% of spinal injuries are secondary to trauma. Neglected spinal instability may lead to severe complications such as intractable pain, post-traumatic deformity, or neurologic deterioration. Flexion-distraction injury (FDI) accounts for 5 to 15% of all spinal injuries and most commonly occurs in the thoracolumbar region. It is sometimes confused with...
a compression or burst fracture and inappropriately treated with an orthosis; the posterior column disruption eventually leads to complications.\textsuperscript{3,4}

Radiography is the initial investigative tool for the injured spine.\textsuperscript{5-7} In patients with FDI, posterior column disruption usually occurs through the ligaments (rather than bone), and spinal stability should be achieved by open reduction and internal fixation.\textsuperscript{8,9} There is usually an associated compression fracture in the anterior part of the vertebral body, and simple distraction force through the pedicular screws can aggravate posterior injured elements (although it can also reduce the anterior fracture). To prevent this, posterior tension band wiring is added to the usual posterior instrumentation to oppose the dissociation of the posterior element while reducing the anterior vertebra. This study evaluated treatment outcome of tension band wiring followed by posterior spinal fusion and instrumentation for thoracolumbar FDI.

**MATERIALS AND METHODS**

Between July 2007 and April 2011, 36 men and 12 women aged 21 to 56 (mean, 36) years underwent tension band wiring followed by posterior spinal fusion and instrumentation using pedicular screws for FDI of the thoracolumbar spine. Patients who underwent direct anterior decompression (for severe neurologic deficit) or direct anterior vertebral reconstruction\textsuperscript{10} (for McCormack classification of >6) were excluded, as were those who were followed up for <24 months. The mechanisms of injury included road accident (n=26), falling (n=14), crush injury (n=6), and equestrian accident (n=2). 16 of the patients had other associated fractures of the spinal column or extremities. The injured vertebral levels were T11 (n=2), T12 (n=12), T11-T12 (n=1), T12-L1 (n=1), L1 (n=28), and L2 (n=4). The mean time interval from injury to surgery was 8 (range, 2–12) days.

Radiography and computed tomography of the thoracolumbar spine were obtained, and anterior vertebral body height and kyphosis were measured. The latter was done by drawing lines parallel with the superior and inferior end plates of the intact adjacent upper and lower vertebrae, respectively. For those with an associated neurologic deficit or suspected posterior ligamentous injury, magnetic resonance imaging (MRI) was also performed. Neurologic status was assessed using the American Spinal Injury Association (ASIA) scale.\textsuperscript{11} In 2 patients, definitive diagnosis (disruption of the posterior ligamentous complex) could only be made during surgery.

Patients were placed in a prone position, with 2 transverse rolls under the chest and pelvis to create thoracolumbar hyperlordosis. Most reductions were achieved with this positioning and also with gentle, manual hyperextension force. The posterior surface of the spine was cautiously exposed, and pedicular screws were inserted into intact vertebrae above and below the injured vertebra. The tension band wire was then added and tightened on the upper and lower intact spinous processes (Fig.). Two longitudinal rods with appropriate lordosis posture (about 5º more than normal regional lordosis) were inserted, and then about 5 mm distraction of the screws was applied to reduce the compressed vertebral bodies, while the injured spine was tightly maintained, using rigid, more posteriorly oriented wires. The rest of the procedure (facetectomy, decortication, and spondylodesis) was conducted routinely.

Postoperatively, a thoracolumbosacral orthosis was used for about 3 months. Patients were followed up at months 1, 3, 6, and 12 and yearly thereafter. The Oswestry Disability Index questionnaire and visual analogue scale for pain were used.\textsuperscript{12-14} The percentage of correction of kyphosis was calculated relative to normal, straight thoracolumbar sagittal alignment. Loss of correction was determined at the final follow-up. Pre- and post-operative outcome was compared using the Student’s paired t-test. A p value of <0.05 was considered statistically significant.

**RESULTS**

The mean follow-up was 38 (range, 26–72) months. At final follow-up, the mean visual analogue scale for pain was 1.7 (standard deviation [SD], 0.5; range, 0–4), and the median Oswestry Disability Index was 4% (range, 0–32%). The mean anterior vertebral body height improved from 20.5 (SD, 4.2) to 38.8 (SD, 4.1)
mm (p<0.001), with a mean percentage correction of 95.1% (SD, 2.2%) and loss of correction of 2.1 (SD, 1.8) mm. The mean kyphosis improved from 20.4º (SD, 3.6º) to 1.5º (SD, 2.2º) [p<0.001], with a mean percentage correction of 90.3% (SD, 3.1%) and loss of correction of 3.1º (SD, 1.4º). Four patients had persistent neurologic deficit: ASIA scale C (n=2) and D (n=2); their ASIA scales improved by one grade. All patients returned to their original work at 6 months.

There were no intra-operative complications or implant failures. One patient developed symptomatic deep vein thrombosis, which resolved with medical treatment. Anti-thrombotic drugs were not used to avoid the risk of an epidural haematoma; ambulation was encouraged as early as possible after surgery. Another patient had a superficial wound infection, which healed with oral antibiotic therapy and local wound care.

**DISCUSSION**

About 50 to 60% of spine injuries occur at the thoracolumbar area, and the most commonly injured vertebrae are L1 (50%), T12 (25%), and L2 (21%). This is consistent with the findings of our study. 10 to 15% of these injuries are FDIs (type B of the AO classification), and include 3 subtypes: B1 (posterior disruption predominantly ligamentous), B2 (posterior disruption predominantly osseous [true Chance fracture]), and B3 (a hyperextension shear injury with anterior disruption through the disc). The severity of injury depends on posture and instantaneous axis of rotation at the time of the injury. Depending on the axis of flexion, the vertebral body and disc may fail in compression or tension in FDIs.

MRI is useful in evaluation of posterior ligamentous injury. Comparing MRI with intra-operative findings, MRI has a high diagnostic accuracy and inter-observer reliability. In our study, only 2 patients with a normal MRI had a posterior ligamentous injury subsequently identified intra-operatively.

A high rate (40%) of associated abdominal injury is reported in Chance-type fractures. The most common viscerae involved are the bowel and mesentery. Comprehensive abdominal studies are thus advocated. In our study, no patient had an abdominal injury, but there were 8 rib fractures, 4 transverse process fractures, 2 leg fractures, and 2 femoral shaft fractures. The absence of abdominal injury in our patients may be due to exclusion of the more severely injured patients who underwent anterior reconstruction.

Surgical instrumentation enables immediate stabilisation, more rapid mobilisation, and more reliable neurologic recovery. In most patients with FDI (except for those with associated severe burst fractures), canal compromise is not significant and therefore direct decompression is not needed. Surgical procedures for unstable injuries usually involve indirect deformity correction, posterior fusion and instrumentation with pedicular screws and rods.

Surgical procedures for FDIs secondary to interruption of the posterior ligamentous complex differ from those for other spinal injuries such as burst fractures, and simple distraction is not indicated. In our study, the posterior spine was first reconstructed with tension band wiring, followed by open reduction with gentle distraction. In a study of 19 young adults who underwent posterior hybrid instrumentation (thoracic hooks and lumbar pedicular screws) without any posterior tension band wiring, the surgical outcome was good, but neurologic deficit in 9 of the patients (2 with ASIA scale B and 7 with ASIA scale A) persisted without any improvement. The mean kyphosis improved from 13º (range, 4º–35º) preoperatively to 4º (range, 0º–11º) at the final follow-up. In our study, neurologic deficit persisted in 4 patients (2 with ASIA scale C and 2 with ASIA scale D), but their neurological scales improved one grade. The mean kyphosis correction was higher (from 20.4º to 1.5º); this may be due to the use of pedicular screws only, compared to the use of hooks and screws.

A study reported a high rate of implant failure after posterior short-segment pedicular screw fixation for FDIs. There were 18 hardware failures involving 20 pedicular screws (8 loose, 7 bent, and 5 broken). This was likely due to improper use of a short-segment construct for these highly unstable thoracolumbar injuries. In our study, short-segment pedicular screws were not used.

**CONCLUSION**

Posterior tension band wiring followed by posterior spinal fusion and instrumentation for thoracolumbar FDIs achieved good outcome.

**DISCLOSURE**

No conflicts of interest were declared by the authors.
REFERENCES