Review of 31 cases of anterior thoracolumbar fixation with the anterior thoracolumbar locking plate system

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Anterior fixation devices for the thoracolumbar spine have gained wide acceptance as viable alternatives to long-segment posterior fixation in cases of thoracolumbar spine trauma. This review was undertaken to evaluate the safety and efficacy of the Synthes anterior thoracolumbar locking plate (ATLP) system.

Over a 3-year period, 31 patients with unstable traumatic fractures of the thoracolumbar spine underwent corpectomy, placement of a structural bone graft, and anterior fixation in which the Synthes ATLP system was used. Long-term follow-up data were obtained in 29 patients. Two patients were lost to follow up, one at 4 months and the other at 1 year. In the remaining patients, the average length of follow up was 20 months. In all patients radiographic evidence of solid bone fusion was demonstrated on follow-up plain x-ray films, and there were no signs or symptoms of pseudarthrosis. No patient suffered neurological deterioration as a result of surgery, and there was relatively little morbidity associated with this plating system. To date, none of the patients in this study has developed any delayed complications related to the fixation device. In one patient, who had sustained a severe flexion injury, loosening of the anterior fixation device occurred, and the patient developed progressive kyphosis, which required a posterior stabilization procedure.

These results appear slightly better than those obtained in published studies in which other anterior plating systems were used, indicating that this system is safe and effective in the treatment of unstable fractures of the thoracolumbar spine.

Key Words * anterior thoracolumbar fixation * spinal fixation * thoracic spine * lumbar spine

The anterolateral thoracoabdominal approach to the thoracic and lumbar spine is well documented in the literature and has been proven to be effective and safe in decompressing the spinal canal.[2,4,5,10,14-16] This approach offers the advantage of direct visualization of anterior and middle column pathological entities, as well as allowing an anterior strut to be placed without having to work between the nerve roots as one would via a posterior approach. In several studies this approach has also been shown to be the most consistent with regard to achieving complete decompression of the neural elements.[1,6] In the past, when a vertebrectomy was performed and a strut graft was placed via this approach, a posterior...
fixation was also performed to stabilize the anterior fusion. Several anterior plating systems have been developed that have come into widespread use for stabilizing the thoracolumbar spine. The anterior plate offers several advantages over a posterior stabilization. First, it allows the stabilization procedure to be performed at the time of the decompression, precluding the need for a second posterior procedure. Second, it provides a rigid construct while only sacrificing two motion segments. In this paper, we report our experience in using the anterior thoracolumbar locking plate (ATLP) system (Synthes Spine, Paoli, PA) in the treatment of unstable injuries to the thoracolumbar spine.

CLINICAL MATERIAL AND METHODS

Over a period of 3 years, 31 patients underwent an anterior surgical decompressive and stabilization procedure for acute unstable thoracolumbar fractures. All patients had sustained either a flexion-compression-type injury or a more axial loading burst-type fracture. On preoperative computerized tomography scanning 77% of patients showed evidence of bone fracture in all three bone columns. Of the 23% of patients in whom there was evidence of only two-column bone injury, all were thought to have some additional posterior ligamentous instability, which was usually seen as splaying of the posterior elements. One concern with the anterolateral plate is its use in patients with severe posterior column disruption. As stated previously, in all of our patients there was some evidence of posterior element instability, and this was not used to exclude these patients from an anterolateral approach and plating procedure.

The average age of our patient population was 35.5 years (range 16-56 years). Seventy-six percent were male and approximately 45% were smokers. Forty-four percent of the patients sustained an injury from some type of fall from a significant height, 32% were involved in a motor vehicle accident, and 12% were involved in a motorcycle accident. One patient was working under a mobile home when it fell on him and caused a severe flexion injury.

In 58% of the patients L-1 was the involved level, in 23% it was T-12 (Fig. 1), in 12% it was L-2, in 4% it was T-11, and in 4% it was T-10. At the time of the initial neurological evaluation, normal motor strength was demonstrated in 22 patients, mild motor weakness (4/5) in four, incomplete spinal cord or cauda equina injury with less than antigravity strength in three, and complete paraplegia in two patients.

Fig. 1. Computerized tomography scans. Left: Axial slice obtained through the fractured body at T-12 showing injury to all three columns. Right: Sagittal reconstruction showing
vertebral body compression.

All patients underwent surgery via a standard anterolateral, thoracoabdominal approach (Fig. 2). The initial surgical exposure was performed by the general surgery team in all cases, and the neurosurgery team took over once the spine was exposed. The fractured level was easily identified by direct inspection, and no localizing x-ray films were obtained.

Fig. 2. The patient is positioned in the lateral position with the table slightly flexed.

Removal of the fractured body was generally performed using rongeurs and large curettes, with the cancellous bone being saved for use as bone graft. A drill was usually used to thin out the posterior cortex prior to removal and to decorticate the endplates prior to graft placement (Fig. 3).

Fig. 3. Intraoperative photograph showing the fractured body prior to removal.

Over the course of our series the source of bone for the strut graft changed from primarily autologous iliac crest to allogenic femur packed with autologous cancellous bone (Fig. 4). We believe that this currently used graft material provides a solid structural support and allows the use of autologous bone without causing the morbidity associated with harvesting the patient's iliac crest. Overall in our 31
patients, we used autologous iliac crest in 57%, allograft femur packed with autologous cancellous bone in 36%, and allograft iliac crest in 7%.

An intervertebral spreader was used to distract the vertebral bodies while placing the structural bone graft. When the distraction was released, the graft was compressed and held firmly in place (Fig. 5 upper). After this the appropriately sized plate was chosen and then held in place by using the two compression screws that are part of the ATLP system (Fig. 5 lower). In our study, the average plate length was 89.3 mm, and the average screw length was 42.5 mm. In approximately half of the cases shorter-length screws were used in the vertebral body above (Fig. 6).
Fig. 5. Upper: The graft is in place prior to plating. Lower: The graft and plate are shown in the final position.
The average length of surgery was 4 hours and 45 minutes, and the mean blood loss was 740 ml. Both operative time and blood loss have steadily declined as we have gained more experience with this technique. Although a chest tube was placed in 57% of patients at the time of surgery, we have recently successfully avoided using chest tubes by primarily repairing any defects in the pleura and following the patients clinically and radiographically. To date, we have not had to place a chest tube in any of these patients postoperatively.

RESULTS

There was only one significant intraoperative complication in our series, which occurred in a patient when the aorta was inadvertently punctured while performing the corpectomy. The blood loss was immediately controlled using direct pressure, and the laceration was directly sutured. During the laceration repair, the aorta was cross clamped for a short period of time. The patient suffered no adverse effects from this injury.

Two patients suffered minor wound-related complications: a wound seroma in one patient required bedside drainage and a superficial wound infection in another patient cleared up with local wound care.

Of the morbidity indirectly related to the surgery, the most common complication was a urinary tract infection, which occurred in approximately 25% of the patients, all of whom responded to a brief course of oral antibiotic drugs. Four patients suffered postoperative atelectasis and all were treated adequately with chest physiotherapy for several days. One patient suffered an ileus requiring placement of a nasogastric tube, and another patient developed severe alcohol withdrawal that required intravenous anxiolytic therapy and an extended hospital stay. Overall there was no major long-term morbidity directly related to the surgery. Thirty-four percent of patients suffered some type of mild postoperative complication that was treated during their hospital stay. The average length of stay was 12.7 days, but this also included the time several patients spent in our inpatient rehabilitation unit.

Seventy-one percent of our patients were fitted with a rigid thoracolumbosacral orthosis brace postoperatively, and the remaining patients were placed in lumbosacral corsettes. Because we have yet to see any major problems with the use of only the corsette, we have started to use it more routinely. All patients underwent anteroposterior and lateral plain radiographic studies immediately postoperatively, and these x-ray films were used as a baseline when the patient was seen at follow up.

In one patient who had suffered a severe flexion injury, early loosening of the fixation device occurred, with a progressive kyphosis. This patient then underwent an operation for a short-segment posterior stabilization to reconstruct the posterior tension band and went on to develop a solid arthrodesis anteriorly. Three patients developed mild kyphosis ($\leq 10^\circ$) that was observed on their immediate postoperative x-ray films, but this did not change on later follow-up radiographs. The average length of follow up was 20 months (range 4-36 months). One patient, who was seen at 4 months and lost to follow up thereafter, appeared to have radiographic evidence of fusion and was doing well clinically at the time of his last visit. Of the 28 patients with at least 6 months of follow-up review, evidence of fusion on plain x-ray films was demonstrated in 25. One of the other three patients subsequently developed radiographic evidence of fusion at 9 months. In one patient complete bone fusion was not evident until 18 months postoperatively; his spine remains well aligned, and there is no evidence of movement of his fixation...
device. The other patient still has a lucent line at the bottom of his graft at 9 months postoperatively. Despite this, his graft is well aligned, and there has been no loosening of the hardware. Radiographs did not show any change in alignment from his initial postoperative studies, and no movement has been shown on dynamic x-ray films. Clinically he is doing very well, without significant back pain. Also of note, this patient is one of two who received allogenic iliac crest.

No patient suffered neurological worsening as a result of the surgery. In patients with preoperative neurological deficits some improvement was generally shown. Three patients who presented with mild weakness but could still overcome gravity, eventually recovered full motor strength. One patient who presented with 2/5 motor strength in both lower extremities secondary to a spinal cord injury improved to the point that he could ambulate with a walker. One patient who presented with a cauda equina syndrome and experienced only minimal motor function and preserved sensation regained full strength and can ambulate without assistance. One patient presented with 3/5 dorsiflexion of one foot and showed only slight improvement at follow-up examination. The patient who presented with complete paraplegia has regained movement in the legs and continues to undergo physical therapy. He has been fitted with long leg braces and is being trained to walk with adaptive equipment. Regarding bowel and bladder control, the patient who presented with an incomplete injury and significant motor weakness initially required self catheterization but now has recovered normal bladder function. The patient who was completely paraplegic remains paraplegic with significant bowel and bladder dysfunction.

**DISCUSSION**

There are a number of anterior fixation devices that have been used for stabilization of the thoracic and lumbar spine. Several studies have recently been performed to examine the biomechanics of anterior fixation devices. Gurr and colleagues[8] have compared the stability of three anterior stabilization constructs with four different posterior stabilization devices in a calf spine model. They found that after corpectomy and placement of a strut graft, the Kaneda anterior plate was similar in rigidity to the posterior instrumentation in which pedicle screws are placed two levels above and below the corpectomy level. Gurwitz and coworkers[9] have compared short-segment posterior fixation to short-segment anterior fixation, both with and without the use of an anterior strut graft. They found that anterior instrumentation with a strut was 12% more rigid than a short-segment posterior fixation with a strut. One concern of using such a rigid fixation device is the potential for increasing the amount of device-related osteopenia. Harris, et al.,[11] have examined the amount of compression strain through a strut graft after placement of an anterior plate, and the ATLP system reduced the compressive strain through the graft to 34% of the graft-alone construct. The Amset anterior plate system reduced the compressive strain to only 77% of the graft-alone construct, showing that the ATLP plate provided a more rigid fixation. This lack of compression through the graft with the ATLP system results in stress shielding of the fusion, which could potentially lead to pseudarthrosis or late complications of fusion failure. In our series of 31 patients we have not observed these problems. Our results appear to be slightly better than those obtained in studies in which other devices were used, suggesting that increased device rigidity may actually be better, despite the increased stress sheilding of the bone graft.

Dick and associates[3] have evaluated the fatigue strength of four different anterior thoracolumbar plating systems. They found the ATLP system was the stiffest in axial compression, lateral flexion, and torsion. In analyzing their data and the results in our series, as well as other reported results obtained when using the Z-plate (which also has a long fatigue life according to Dick, et al.), the increased rigidity of the plate seems to be associated with a lower pseudarthrosis rate. Although there are no clinical series
in which the use of the ATLP system is exclusively reported, several authors have reported their results with the Z-plate, the Kaneda device, and other anterior plating systems.[12,13] Ghanayem and Zdeblick[7] reported their results with the Z-plate for treatment of unstable thoracolumbar fractures. In their series, in 11 of 12 patients a good or excellent outcome was obtained, but two patients were found to have lost 10° and 20°, respectively, of their reduction at follow up. Kaneda and colleagues[12] have recently reported on their results using the Kaneda device in 150 patients in whom burst fractures of the thoracolumbar spine were associated with neurological deficits. Their overall fusion rate was 93%, with a mean of 8 years of follow up. Ten of their patients developed a pseudarthrosis that required subsequent posterior fixation. They also reported breakage of the Kaneda device in nine patients. One advantage of the Kaneda device is that it allows the graft to be placed under compression by the actual fixation device. The ATLP system has two smaller compression screws that compress the graft prior to placement of the vertebral body screws, but the amount of compression one can obtain is definitely limited.

Overall we have had very satisfying results in using the ATLP system for anterior stabilization after decompression and fusion in patients with unstable thoracolumbar spine fractures. We believe that the plate application is relatively simple for the surgeon, and our fusion rates to date have been excellent.

CONCLUSIONS

Anterolateral approaches to thoracolumbar spine fractures can be an effective means of treating these injuries. The development of safe and effective anterior fixation devices allows both decompressive and stabilization measures to be achieved via this approach. In our series the results have shown that the ATLP system is both safe and effective in the treatment of unstable injuries of the thoracolumbar spine. Additional long-term follow-up evaluation is necessary to demonstrate what, if any, long-term effects this rigid fixation device will have on the arthrodesis.

References


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