

Transpedicular Reduction, Bone Grafting and Pedicular Screw Plating for Thoracolumbar and Lumbar Spine Fractures and Other Spinal Disorders

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Abstract : The authors sought the utilization of a ready available and inexpensive system which gives the stability of a vertebral fracture, immobilizing only 2 spinal motion segments. This report details the experience using AO-plates as pedicular screw plating, for the treatment of spinal fractures and disorders in the thoracolumbar and lumbar area. Forty-four patients were review, 37 patients of which had acute spinal trauma, 1 malunion, 2 degenerative instability, 3 spondylolisthesis and 1 tuberculosis of the spine. We concluded that this instrumentation was effective in the posterior fixation of the spine, particularly in the spinal fractures.

INTRODUCTION

King¹ in 1948 used interpedicular fixation as a method of arthrodesis. Boucher² in 1959 first described passing long screws through the lamina and pedicle into the vertebral body below as a mean of temporarily stabilizing L4 to L5 to S1 fusion with very good results.

Since 1963, Roy-Camille³ has used pedicle screw plates in spinal fixation. This paved the way for Magerl⁴'s external fixator (1977) of vertebral fractures with the aid of transpedicular screws and for posterior segmental fixation with Dick⁵'s internal fixator (1982). Steffee⁶ (1986) has developed a special plate with rigidly fixed plate screw interface.

Roy-Camille pedicle screw plating system requires fixation of 5 vertebrae or four motion segments. Kahanovitz⁷ had shown of osteoarthritic changes of the unfused facet joints in the patient who was treated by " long rod-short fused " technique. The authors sought the utilization of a readily available and inexpensive system for short segment fixation of the thoracolumbar and lumbar spine. The concept presented here was the fixation of the spine with the transpedicular fixation using AO-DCP plate or AO-spinal plate. Direct repair of the burst vertebral fracture with transpedicular bone graft was supplemented as an intergral part of the fixation of burst fractures.^{8,9}

MATERIALS AND METHODS

From February 1987 - September 1990, transpedicular screw plating was performed in 44 patients, the mean follow up period was 9.8 months (3-29 months)

The indication included acute spinal trauma 37 cases, malunion (1 case), spondylolisthesis (3 cases), two degenerative instability (2 cases) and one - tuberculosis. The mean ages of the spinal trauma patients was 29.9 years. Classification of McAfee¹⁰ for acute trauma was used, most of them was burst fracture (Table 1). Fourteen patients had neurologic deficit (Frankel¹¹'s classification). Thirteen cases had associated injuries. Four had multiple injuries. Removal of implants was recommended after 9 months for unfused and 18 months for fused vertebral. Generally we use AO-DCP narrow plate or AO-spinal plate with 4.5 mm. cortical screw. For small pedicle, AO-small DCP plate was used. In some cases posterior interspinous wiring with 15 or 18 gauge stainless steel wire may be added to increase the stability.

Table 1. Injury Pattern According to McAfee's classification

Injury Pattern	No of Spine
Wedge-compression fracture	1
Stable burst fracture	17
Unstable burst fracture	13
Flexion-dislocation injury	4
Translation injury	4
Total	39

*One patient had multiple fractures (stable burst fractures of L1 and L2 and wedge-compression fracture of T12).

SURGICAL PROCEDURE

In the lumbar spine, the pedicle entry point is situated on the vertical bony crest at the point 1-2 mm. medial to the lateral border of the cranial articular process. In the thoracic region the entry point is situated about 1 mm. below the mid portion of facet joint. Starting from these points, a 2 mm. drill bit is driven by hand through the pedicles into the vertebral bodies in a parallel plane to the end plates, converging towards the midline 0-10 degrees in the thoracic and 15 degrees in the lumbar region. The length of the screw is approximate 40 mm. in depth (30 mm. for the small size vertebra). An image intensifier is used to check the direction of the pins. To perform the reduction, a 3.5 mm. cortex screw is driven into the pedicle above and below the fractured vertebra at one side. With the use of a pelvic reduction clamp, applying over the protruded end of the screws, the fracture can be reduced and transpedicular bone graft is performed. The vertebral height of the burst fracture and the flexion distraction injury are restored by distraction and compression respectively. As the distraction force is applied by using the pelvic reduction clamp, a custom-made punch is brought through the pedicle into the vertebral body under image intensifier control (Fig. 1). The upper end plate and anterior wall are reduced. After the reduction of a compressed vertebral body, the defect in the cancellous bone is packed with autogenous bone graft (Fig. 2). Later in this series, an intraoperative myelography following reduction was routinely carried out in cases with neurologic deficit. This reduced markedly the need for laminectomy. While the reduction is maintained with the pelvic reduction clamp on one side, a plate is applied on the another side. The usual osteosynthesis includes only 3 vertebrae or 2 motion segments. When the screws are tightened the kyphosis is corrected and the vertebral height is restored. In burst fracture, posterior interspinous wiring may be added to increase the stability. All patients receive a Taylor-Brace for the thoracolumbar and lumbosacral support for the lumbar region for about 3 months. Prophylactic antibiotic with first generation cepharosporin is routinely used for 24-48 hours postoperatively.

RESULTS

Pain, recovery from the neurologic deficit and correction of the kyphotic angle were used for evaluation. Pain was classified as mild, moderate and severe (mild : occasional pain, need no analgesics; moderate pain : occasional pain, analgesics required; severe pain:regular analgesics required). Kyphotic angle was measured by Cobb's method. Pain was absent or mild in 89.2% . In those patients with a partial neurologic deficit, there was recovery of at least one Frankel's grade in all 14 patients. No patient with complete cord lesion regained functional recovery. One patient with unstable burst fracture of L3 and complete paraplegia of Frankel grade A (cauda equina lesion) had recovered from the neurologic deficit to Frankel's grade D (Table 2). The overall kyphotic

deformity in thoracolumbar junction was reduced from 29° to 2° and in the lumbar region from 2° kyphosis to 9° lordosis. Final postoperative angle was average 7° kyphosis in the thoracolumbar junction and average 2° lordosis in the lumbar region (Table 3).

The complication included only mechanical complications specific to transpedicular instrumentation such as screw loosening (no such a case occurred before bone healing) and laterally placed screw (3% of total screw inserted).

In addition to acute spinal injuries the pedicle screw plating was also applied to other spinal disorders : malunion, spondylolisthesis, degenerative spinal instability and tuberculosis of the spine. One patient was operated for malunion of L3 burst fracture, surgery was done in 2 stages, by anterior release with cortico-cancellous bone graft, 10 days later the reduction was stabilized with the transpedicular screw plating and interspinous wiring. No additional posterolateral fusion was done. Six months after the operation the fracture was healed and the patient is asymptomatic (Fig. 3). The authors used the transpedicle screw plating for the treatment of grade I spondylolisthesis at either L4-5 or L5-S1 in 3 patients. L3-S2 was spanned with the fixation system. A laminectomy and a posterolateral fusion were always added. The patients were able to ambulate early with L-S support following surgery (about 10-14 days). (Fig. 4).

Result of treatment of spinal stenosis associated with degenerative disease of the lumbar spine in 2 patient have been encouraging. After the laminectomy the unstable spinal segments were stabilized to enhance the posterolateral fusion. Postoperative pain and neurologic claudication have been decreased significantly (Fig. 5).

Tuberculosis of L2 with translational instability in a 69 year old man was stabilized with the pedicle screw plates and a posterolateral fusion was done from L1 to L3. Preoperatively this patient had a severe pain that limited him to lie only in bed. The pain subsided 4 months postoperative.

Table 2. Frankel Grades

	Preoperative	Follow up				
		A	B	C	D	E
A	4	3			1	
B	5			4	1	
C	5				3	2
D	—				—	
E	23				23	
Total	37	3		4	28	2

Table 3. Kyphotic Angle

Vertebral Level	Preoperative	Postoperative	Follow up	Loss of Reduction
T10-L1	20°	2°	7°	5°
L2-L5	2°	-9°	-2°	7°

- = Lordosis

DISCUSSION

According to our surgical technique the plate includes only short segments (3 vertebrae) and the pedicular screw are not mechanically rigidly linked to the plate. The screws might fail under physiological cyclic loading before the healing of the reduced vertebral fracture. The initial stability can be improved by the transpedicular bone grafting to prevent screw-bone interface loosening. The pedicle screw plate can be applied at the lumbar and lumbosacral region without iatrogenic loss of the physiologic lumbar lordosis. Partial or complete loss of the reduction following Harrington instrumentation is commonly observed^{13,14,15}. The combination of Harrington distraction rods and sublaminar wiring has become more popular in operative stabilization of the spinal fractures^{16,17,18,19,20} but the problem of long fixation technique remains, that is the obstacle to achieve physiologic spinal motion.

In the present series it had been shown that the transpedicle

screw plating permitted stabilization of the spine over a short segment. The cost of the implants is 12 times lower than that of the imported fixateur interne. Certainly, the risk of improper placement of pedicular screws may occur^{21,22}. In the present series there was no serious complication related to the placement of the pedicular screws.

CONCLUSION

The advantage of the pedicular screw plating in combination with transpedicular-reduction and bone grafting includes immediate stabilization of all types for spinal fusion. Instrumentation described here in has been proven to be a valuable adjunct in operative stabilization of the thoracolumbar and lumbar spine. The implants and instruments are ready available at all centers equipped with AO-instrument sets.

We conclude that the pedicular screw plating is effective for posterior fixation of the spine, particularly in spinal fracture, it can preserve the spinal mobility and is cost effective.

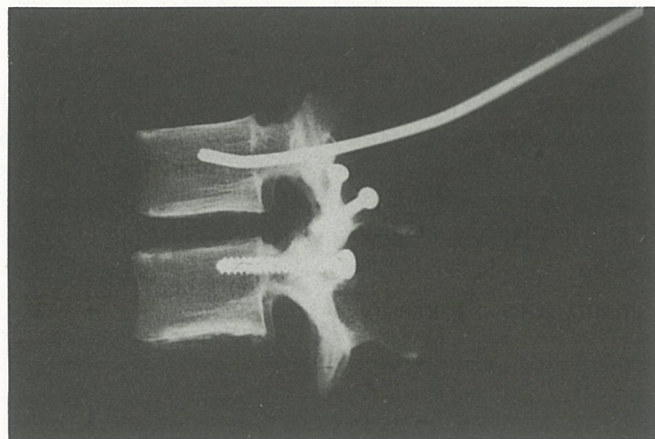


Fig. 1 Transpedicular-reduction. As the distraction force is applied by using the pelvic reduction clamp, a custom-made puch is brought through the pedicle into the vertebral body, to reduce the fracture directly.

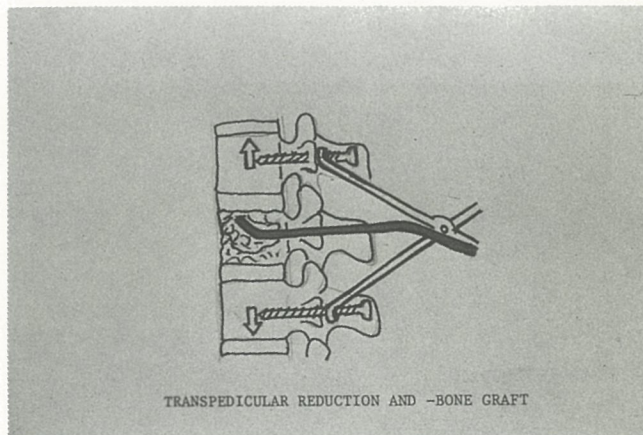


Fig. 2 Transpedicle bone graft. After reduction, the bony defect in the reduced vertebra is filled with an autogenous cancellous bone graft, inserting through the pedicle.

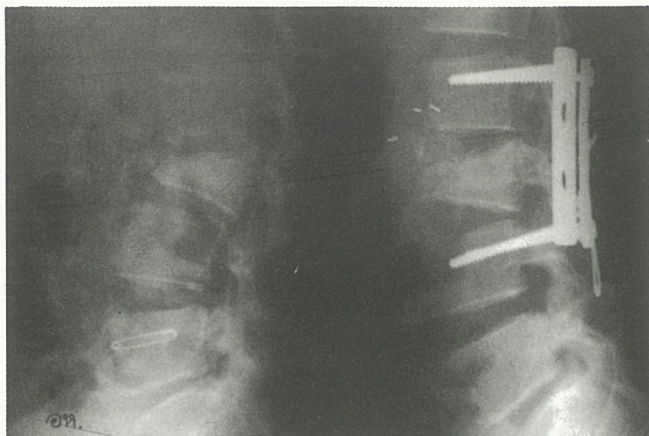


Fig. 3A A 42 year old man. Burst fracture of L3 treated conservatively. Four months after injury he had symptom and sign of spinal stenosis with marked kyphotic deformity.

Fig. 3B Postoperative radiograph after anterior release with bone grafting and pedicle screw plating plus interspinous wiring.



Fig. 4A A 50 year old man. Spondylolysis spondylolisthesis of L5-S1 grade I with radiculopathy on the left.

Fig. 4B Postoperative roentgenogram shows the reduced spinal segment L5-S1. The patient was mobilized with a lumbosacral-support ten days after the operation.



Fig. 5A A 46 year old woman with classical symptoms of neurogenic claudication due to spinal stenosis. Maximal flexion film and

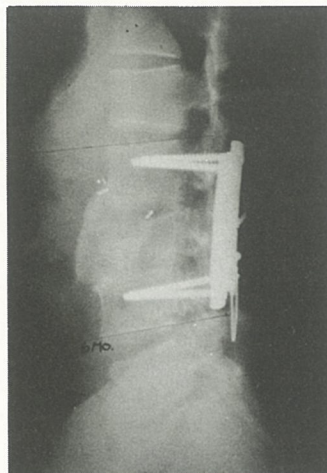


Fig. 3C Sixth months after surgery he is asymptomatic.

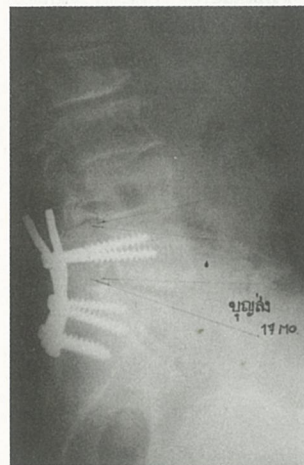


Fig. 4C Postoperative roentgenogram seventeen months after surgery shows loss of reduction but the fusion is achieved and the patient asymptomatic.

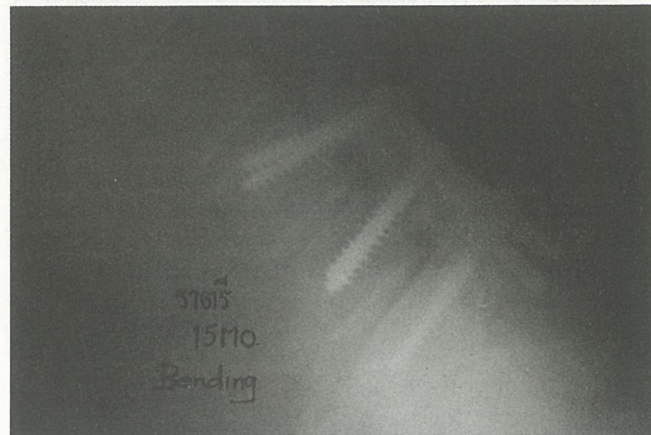


Fig. 5C In standing



Fig. 5B Extension film in functional roentgenogram show unstable L3-4 segment. A laminectomy, dissection, pedicle screw plating and posterolateral fusion were performed. Intraoperative the dura had been inadvertently torn during laminectomy, postoperative she had developed paraparesis, which showed progressively improvement. Postoperative roentgenogram twelve months after operation in maximal flexion and

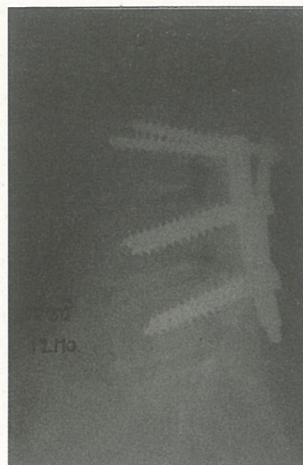


Fig. 5D Show stable L3-4 segment. At the last follow up, 15 months after surgery the patient has no pain and almost normal neurologic status.

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