THORACOLUMBAR JUNCTION INJURIES AND THEIR MANAGEMENT WITH PEDICLE SCREWS

Inayatullah Khan, Muhammad Nadeem, Zia Hassan Rabbani
Department of Neurosurgery, Shifa International Hospital, Islamabad, Pakistan

Background: To evaluate the use of pedicle screw fixation in earthquake injured thoracolumbar spine**. Methods:** Nineteen patients with posttraumatic instability of lower thoracic or upper lumbar spine were included in the study. White and Panjabi criteria was used to assess spinal instability. All patients underwent open reduction and internal fixation by posterior approach. Pedicles were localized using detailed anatomical landmarks and intraoperative imaging. . Local bone was used as bone graft. The neurological status of the patients and any other complications were noted up to one year. **Results:** There were 19 patients with unstable thoracolumbar junction injuries who were managed with pedicle screws and rods. Females were more affected (F:M ratio was 8.5:1). Wedge compression was the commonest. None of the patients deteriorated after surgery. There were 20 Frankel improvements in 18 patients (1.11 Frankel on average) with neurological deficit whereas 1 patient in Frankel E remained in the same grade on subsequent follow-ups. There was one patient with wound infection and one patient developed DVT. None of the patients developed bedsores. **Conclusion:** Pedicle screw fixation is a useful choice for thoracolumbar junction injuries for achieving reduction and stability in both anterior and posterior column injuries, without affecting extra motion segments.

Keywords: Pedicle screws, thoracolumbar junction injuries

INTRODUCTION

The thoracolumbar junction injuries are the commonest spinal injuries.[1,2] The treatment of unstable fractures and fracture dislocations of thoracolumbar spine remains controversial.[3]

The goal of the treatment of unstable thoracolumbar injuries is optimising neural decompression while providing stable internal fixation over the least number of spinal segments.[4] Either anterior posterior or both approaches can be used to achieve fusion but the efficacy of either approach is the same.[5-7] However, posterior approach is less extensive.[8]

Pedicle screw devices allow immediate stable fixation as the screws traverse all the three columns.[9] The pedicle screws are passed one level above and one level below the injured vertebra via posterior approach.[10]

The aim of this study was to evaluate the use of pedicle screw fixation for preservation of remaining spinal cord function, restoration of spinal alignment, achievement of pain-free fracture site, early mobilization and maximization of neurological recovery in earthquake injured patients.

MATERIAL AND METHODS

Nineteen patients with posttraumatic instability of lower thoracic or upper lumbar spine were surgically managed at the Department of Neurosurgery, Shifa International Hospital, Islamabad after 8th October earthquake. All those patients who were operated for thoracolumbar junction injuries with pedicle screw fixation were included. The patients with pre-existing systemic illness or associated extra spinal injuries significant enough to result in increased morbidity or mortality were excluded from the study.

A detailed history and examination was carried out especially evaluating the mode of trauma, Frankel grading[11] (Table-1), sensory level and any spinal deformity. Plain x-rays, in anteroposterior and lateral views were obtained and the instability of the spine was confirmed using White and Panjabi criteria[12] of spinal instability (Table-2). MRI or CT scan was done to further evaluate the important relationships and instability of spine. Those patients with unstable spine were then explained pros and cons of the surgical treatment. Patients willing for surgery were included in this study. All patients underwent open reduction and internal fixation by posterior approach. Laminectomy to decompress spinal cord was carried out at the involved level and bone was saved to be used as bone graft. Pedicles were localized using detailed anatomical landmarks and intraoperative imaging. Polyaxial screws were inserted through pedicles into vertebral bodies' one level above and one level below fractured vertebra under fluoroscopic guidance. Rod contouring using a French bender was employed in all the cases. The rod was coupled to polyaxial screws. Distraction of anterior elements was produced by compressing the heads of Polyaxial screws by which annulotaxis was used for reduction of spinal deformity. The rotational movement was prevented by transverse traction device. The cortical bone was roughened using high-speed drill to make suitable for bone graft. The bone already saved while doing laminectomy was broken into small fragments free of soft tissue and was placed over roughened cortical bone. The wound was then closed in layers after keeping a Redivac drain.

The patients were kept on broad-spectrum antibiotics and analgesics for one week. The drain was removed on the next day of surgery. Check x-rays were done on the 3rd postoperative day. Thoracolumbar support was given to the patients. Aggressive physiotherapy was started to mobilize patients. The neurological status of the patients and any other complications were noted up to one year.

Table-1: Frankel grading for completeness of injury

A	Complete (no sensory or motor function is preserved)
B	Incomplete (Sensory, but no motor function is preserved below the neurological level)
C	Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of <3)
D	Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of ≥3)
E	Normal (sensory & motor function is normal)

Table-2: White and Panjabi criteria of spinal instability (Quantitation of acute instability in sub-axial, cervical, thoracic and lumbar injuries).

Condition	Points assigned
Loss of integrity of anterior (and middle) column	2
Loss of integrity of posterior column(s)	2
Acute resting translational deformity	2
Acute resting angulation deformity	2
Acute dynamic translation deformity exaggeration	2
Acute dynamic translation deformity exaggeration	2
Neural element injury	3
Acute disk narrowing at level of suspected pathology	1
Dangerous loading anticipated	1

A score of 5 points or more implies the presence of instability.

RESULTS

There were 19 patients who were managed with pedicle screws for thoracolumbar junction injuries. There were 17 females and 2 males (8.5:1 ratio). The age range was 11 to 32 years (mean age of 21 years).

McAfee's classification of thoracolumbar injuries was used in our study. Wedge compression was the commonest in 11 patients (58%) whereas Fracture subluxation was seen in 2 patients (10.5%). There were 4 burst fractures (21%), 2 translational injuries (10.5%) and no distraction injuries.

One patient had an infected lacerated wound at back pre-operatively and we waited until the wound became healthy. This patient did well post-operatively.

None of these patients deteriorated after surgery. The neurological status of the patients (Frankel grading) and subsequent improvement is shown in Table-3. The Table-3 shows that the patients are progressively moving from worse grade to a better grade. One patient in Frankel A (complete neurodeficit), who had a wedge fracture of L_1 vertebra showed maximum improvement post operatively and moved to Frankel E (no neurodeficit). There were 20 Frankel improvements in 18 patients (1.11 Frankel on average) with neurological deficit whereas 1 patient in Frankel E remained in the same grade on subsequent follow-ups. Almost complete removal of vertebral body was done to get satisfactory alignment of spine in two cases as shown in Figures 1 and 2.

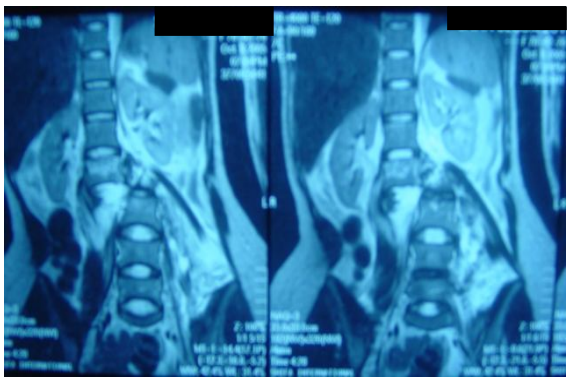

Figure-1: MRI showing complete translational injury at L_3

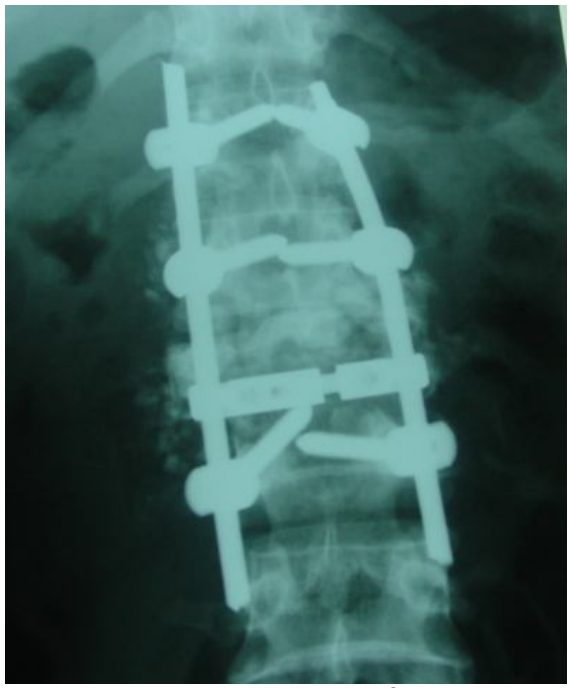

Figure-2: Post-op x-rays showing satisfactory reduction

There was 1 patient (5%) with wound infection and implant failure, which was removed 5 months postoperatively. Bony fusion had occurred at the time of removal of implant. One patient developed DVT. One patient became severely depressed and required long term antidepressants. None of the patients developed bedsores or other complications of recumbency. All the paraplegics could mobilize with zimmers frame independently and could pass urine using crede manoeuvre.

Table-3: Frankel grading of the patients

	A	B	C	D	E
At presentation	17	1	0	0	1
At follow-up	2	13	2	0	2

DISCUSSION

The management of fractures in the thoracolumbar region is a controversial subject.[3,4,13] Disadvantages of conservative treatment include deterioration in neurological status in 17% of the patients,[14] progressive kyphotic deformity in 20%,[15] persistent backache,[16] decubitus ulcer and deep venous thrombosis.[17] Most of these complications can be avoided by early mobilization and decreased hospital stay by early surgery.[18]

The pedicle offers a strong point of attachment of the posterior elements to the vertebral body and pedicle screw instrumentation has revolutionized spine surgery.[19,20] Pedicle screw fixation is considered bio-mechanically superior to other stabilization constructs or parapedicular screws and are exceptionally rigid.[21-24] It has rapidly become one of the most popular strategies for achieving solid fusion.[20] So instrumentation with pedicle screws is a commonly used procedure for correcting deformity and stabilizing the spine until bony fusion occurs.[25] These instrumentation systems may be divided into those using rods and those using plates. Operative stabilization consists of segmental distraction with pedicle screw fixation one level above and one level below the injured segment. By applying distraction, annulotaxis is exploited to aid in reduction of retro-pulsed bone and disc fragments.[26] Similarly, pedicle screws have been shown to be superior to hooks in lumbar spine.[27]

Intraoperative rod contouring using a French bender reduces the fatigue life of spinal constructs.[28] Tapping may decrease the pullout resistance of screws in osteoporotic spine but not in normal spine.[29] We utilized rod contouring and tapping for screw placement in all our cases.

Bony fusion was achieved in 18/19 (95%) of our cases whereas Sasso[30] has reported a 95.6% arthodesis rate with dynamic compression plates and pedicle screws in 23 patients. Sengupta *et al*[31] showed similar fusion rates with iliac crest or local bone in a single level fusion but less morbidity in case of local bone. We also used autogenous local bone as graft in all cases.

Zeiller SC[24] *et al* utilized intraoperative neurophysiological monitoring in addition to anatomical landmarks and intraoperative imaging including neuronavigation. Vougioukas VI *et al*[32] suggested that the computer-aided navigation may be beneficial but does not appear to be mandatory. We localized the pedicles using detailed anatomical landmarks and intraoperative fluoroscopy. None of our patient required re-exploration for correction of screws. Yilmaz C *et al*[25] utilized percutaneous methyl methacrylate injection around a loosened screw but it was not required in our cases. Powers CJ *et al*[23] found a screw breaching the spinal canal in one out of 287 percutaneouly placed pedicle screws but none of our screws breached the spinal canal. This difference may be due to small number of patients in our study or to open technique as compared to percutaneous technique. Knop C *et al*[33] also found 139 out of 2264 screws (6.1%) to be misplaced with open technique but only 0.6% required revision. White[34] reported a 23% screw fractures in a series of 76 patients. In our series, no misplacement or breakage of screws occurred.

Olumide[35] showed 0.4, 1.09 and 0.66 Frankel grade improvements with anterior, posterior and antero-posterior approaches respectively. Nadeem M *et al*[36] showed 0.9 Frankel improvement with one year follow-up while in our study the average improvement was 1.11 Frankel grade with similar one year follow-up. It is important to note that Olumide did not study paraplegic (Frankel A) patients whereas in our series, 17 out of 19 patients (89.4%) were in Frankel A. One patient was neurologically intact (Frankel E) preoperatively as well as on follow ups and was excluded while calculating improvement as by Olumide. Shafiq[6] did not show the neurological improvement whereas significant neurological improvement was shown in our series.

Two to six percent incidence of postoperative wound infection has been reported.[6,37,38] In our series it was 5% (1/19 patients). It was recommended by Sasso that infection could be managed without the removal of hardware.[24] We managed our patient conservatively but could not control infection. So implant was removed. Bony fusion had already occurred by that time and the deformity did not progress on follow-up imaging.
No life-threatening complication occurred in our series.

Shafiq[6] as well as Olumide[35] used external orthosis for three months. It was not used in any of our case because the fixation was strong enough to bear axial loading without external bracing.

CONCLUSION

Thoracolumbar injury was a common neurosurgical problem after earthquake. Surgical treatment is a better option for early ambulation and faster recovery. Pedicle screw fixation is a useful choice, which achieves reduction and stability in both anterior and posterior column injuries, does not require anterior decompression and does not affect extra motion segments.

REFERENCES

1. Mikles MR, Stchur RP, Graziano GP. Posterior instrumentation for thoracolumbar fractures. J Am Acad Orthop. Surg. 2004;12(6):424-35.
2. Kirkpatrick AW, McKevitt E. Thoracolumber spinal fractures: is there a problem? Can J Surg. 2002;45:21-4.
3. Yue JJ, Sossan A, Selgrath C, Deutsch LS, Wilkens K, Testaiuti M, *et al*. The treatment of unstable thoracic spine fractures with transpedicular screw instrumentation: a 3-year consecutive series. Spine. 2002;27(24):2782-7.
4. Sasso RC, Renkens K, Hanson D, Reilly T, McGuire RA Jr, Best NM. Unstable thoracolumbar burst fractures: anterior-only versus short-segment posterior fixation. J Spinal Disord Tech. 2006;19(4):242-8.
5. Danisa OA, Shaffrey CI, Jane JA, Whitehill R, Wang GJ, Szabo TA, *et al*. Surgical approaches for the correction of unstable

thoracolumbar burst fractures: a retrospective analysis of treatment outcomes. J Neurosurg 1995;83:977-83.
6. Shafiq K, Iqbal M, Hameed A, Mian JM. Role of transpedicular fixation in thoracolumbar spinal injuries. Neurol Surg 1998;1:21-7.
7. Sar C, Bilen FE. Flexion was more painful than extension. Thoracolumbar flexion-distraction injuries combined with vertebral body fractures. Am J Orthop 2002;31:147-51.
8. Wesley AC, William TH. Injuries to thoracic and lumbar spine. In: Wilkins RH, Rengachary SS, editors. Neurosurgery. 2nd ed. New York: McGraw-Hill; 1996.p 2987-95.
9. Shafiq K, Ahmed M, Rehman A, Abrar S, Mian JM. Management of unstable lower thoracic and lumbar spine with transpedicular fixation. Ann KE Med Coll 1999;5:303-7.
10. Gregory JB. Lumbosacral stabilization using screw fixation techniques. In: Wilkins RH, Rengachary SS, editors. Neurosurgery. 2nd ed. New York: McGraw-Hill; 1996.p 3027-36.
11. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, *et al*. The value of postural reductions in the initial management of closed injuries of spine with paraplegia and tetraplegia. Paraplegia 1969;7:179-92.
12. White AA III, Panjabi M. The clinical biomechanics of the spine. 2nd ed. Philadelphia: Lippincott; 1990.
13. Tezeren G, Kuru I. Posterior fixation of thoracolumbar burst fracture: short-segment pedicle fixation versus long-segment instrumentation. J Spinal Disord Tech. 2005;18:485-8.
14. Denis F, Armstrong GW, Searls K, Matta L. Acute thoracolumbar burst fractures in the absence of neurologic deficit. A comparison between operative and nonoperative treatment. Clin Orthop Relat Res. 1984;(189):142-9.
15. Willén J, Lindahl S, Nordwall A. Unstable thoracolumbar fractures. A comparative clinical study of conservative treatment and Harrington instrumentation. Spine.1985; 10(2):111-22.
16. Gertzbein SD, Macmicheal D, Tile M. Harrington instrumentation as a method of fixation in fractures of the spine. J Bone Joint Surg Br. 1982;64:526-9.
17. Bradford DS, McBride GG. Surgical management of thoracolumbar spine fractures with incomplete neurologic deficits. Clin Orthop Relat Res 1987;218:201-16.
18. Esses SI, Botsford DJ, Wright T, Bednar D, Bailey S. Operative treatment of spinal fractures with the AO internal fixator. Spine 1991;16(3 Suppl):S146-50.
19. Steffee AD, Biscup RS, Sitkowski DJ. Segmental spine plates with pedicle screw fixation. A new internal fixation device for disorders of the lumbar and thoracolumbar spine. Clin orthop Relat Res. 1986;203: 45-53.
20. Whang PG, Vaccaro AR. Spinal Pedicle Fixation Revisited: The Role of X-rays and Other Surgical Factors. Spine 2006;31(6):717-21.
21. White KK, Oka R, Mahar AT, Lowry A, Garfin SR. Pullout strength of thoracic pedicle screw instrumentation: comparison of the transpedicular and extrapedicular techniques. Spine 2006;31(12):E355-8.
22. Bransford R, Bellabarba C, Thompson JH, Henley MB, Mirza SK, Chapman JR. The safety of fluoroscopically-assisted thoracic pedicle screw instrumentation for spine trauma. J Trauma 2006;60(5):1047-52.
23. Powers CJ, Podichetty VK, Isaacs RE. Placement of percutaneous pedicle screws without imaging guidance. Neurosurg Focus 2006;20(3):E3.
24. Zeiller SC, Lee J, Lim M, Vaccaro AR. Posterior thoracic segmental pedicle screw instrumentation: evolving methods of safe and effective placement. Neurol India 2005;53(4):458-65.
25. Yilmaz C, Atalay B, Caner H, Altinors N. Augmentation of a Loosened Sacral Pedicle Screw With Percutaneous Polymethylmethacrylate Injection. J Spinal Disord Tech. 2006;19(5):373-5.
26. Zou D, Yoo JU, Edwards WT, Donovan DM, Chang KW, Bayley JC, *et al*. Mechanics of anatomic reduction of thoracolumbar burst fractures. Comparison of distraction versus distraction plus lordosis, in the anatomic reduction of the thoracolumbar burst fracture. Spine 1993;18:195-203.
27. Cordista A, Conrad B, Horodyski M, Walters S, Rechtine G. Biomechanical evaluation of pedicle screws versus pedicle and laminar hooks in the thoracic spine. Spine J. 2006;6(4):444-9.
28. Lindsey C, Deviren V, Xu Z, Yeh RF, Puttlitz CM. The effects of rod contouring on spinal construct fatigue strength. Spine 2006;31(15):1680-7.
29. Carmouche JJ, Molinari RW, Gerlinger T, Devine J, Patience T. Effects of pilot hole preparation technique on pedicle screw fixation in different regions of the osteoporotic thoracic and lumbar spine. J Neurosurg Spine 2005;3(5):364-70.
30. Sasso RC, Cotler HB, Reuben JD. Posterior fixation of thoracic and lumbar spine fractures using DC plates and pedicle screws. Spine 1991;16(3 Suppl):S134-9.
31. Sengupta DK, Truumees E, Patel CK, Kazmierczak C, Hughes B, Elders G, *et al*. Outcome of local bone versus autogenous iliac crest bone graft in the instrumented posterolateral fusion of the lumbar spine. Spine 2006;31(9):985-91.
32. Vougioukas VI, Weber J, Scheufler KM. Clinical and radiological results after parapedicular screw fixation of the thoracic spine. J Neurosurg Spine 2005;3(4):283-7.
33. Knop C, Blauth M, Bühren V, Hax PM, Kinzl L, Mutschler W. Surgical treatment of injuries of the thoracolumbar transition. 2: Operation and roentgenologic findings. Unfallchirurg 2000;103:1032-47.
34. White AA 3rd, Panjabi M, Thomas CL. The clinical biomechanics of kyphotic deformities. Clin Orthop Relat Res. 1977;(128):8-17.
35. Olumide AD, Christopher IS, John AJ. Surgical approaches for the correction of unstable thoracolumbar burst fractures: a retrospective analysis of treatment outcomes. Neurosurg 1995;83:977-83.
36. Nadeem M, Ghani E, Zaidi GI, Rehman L, Noman MA, Khaliq-uz-Zaman. Role of fixateur interne in thoracolumbar junction injuries. J Coll Physicians Surg Pak. 2003;13(10):584-7.
37. Roy-Camille R, Sailant G, Mazel C. Internal fixation of the lumbar spine with pedicle screw plating. Clin Orthop 1986;203:7-17.
38. Thalgott JS, LaRocca H, Aebi M, Dwyer AP, Razza BE. Reconstruction of the lumbar spine using AO DCP plate internal fixation. Spine 1989;4:91-5.

Address for Correspondence:
Inayatullah Khan, Department of Neurosurgery, Shifa International Hospital, Islamabad, Pakistan