# UNCONVENTIONAL FIXATION OF THORACOLUMBAR FRACTURES USING ROUND HOLE BONE PLATES AND TRANSPEDICULAR SCREWS

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**Background:** In an attempt to contain the high cost of commercially available pedicle screw systems, several authors have used unconventional alternatives such as locally made plates or dynamic compression plates (DCP) along with cancellous screws for transpedicular fixation of the thoracolumbar spine. These plates, however, allow for a wide range of motion at the plate-screw interphase and the construct does not provide stability in the sagittal plane. Round hole bone plates, on the other hand, allow much less mobility at the plate-screw interphase and the final construct offers better stability in the sagittal plane. Our objective was to determine the clinical, radiologic, and functional status of patients who underwent posterior fracture fixation using round hole bone plates and cancellous screws, and evaluate the construct's ability to maintain reduction of the fracture.

**Patients and Methods:** This was a prospective follow-up of patients with fractures around the thoracolumbar junction fixed using round hole bone plates and cancellous transpedicular screws. Round hole bone plates along with 6.5 mm transpedicular cancellous screws were used for posterior spinal instrumentation in neurologically intact patients with isolated unstable fractures of the last thoracic or first lumbar vertebra.

**Results:** Seventeen patients were included in this study. Their mean follow-up was 10 months (range 5 to 12). All had evidence of fusion at a mean of 5 months (range 4 to 7). No patient had breakage or loosening of the screws and none had breakage of the plate. The mean kyphosis angle at the fracture site was 34° preoperatively, -4° in the immediate postoperative period, and 3° on final follow-up radiographs. The percentage loss of anterior vertebral body height was 51% preoperatively, 15% in the immediate postoperative period, and 16% on final follow-up radiographs.

**Conclusion:** The use of round hole bone plates along with 6.5 mm cancellous screws inserted into the pedicles provides an angle-stable construct that allows for better stability in the sagittal plane. It is effective in the surgical treatment of unstable fractures around the thoracolumbar junction. Because of their low cost and ease of insertion, round hole bone plates are an excellent choice for short arthrodesis and instrumentation of such fractures.

*Ann Saudi Med 2001;21(1-2):30-34.*

**Key Words:** Spine, instrumentation, fractures, lumbar, plate.

Fractures around the thoracolumbar junction are among the most common injuries affecting the vertebral column.[1,2] The most common causes for such fractures are motor vehicle accidents and falls from heights. The fracture pattern depends on the severity of trauma, the patient's age, weight, use of seat belt and body posture at time of accident. These fractures are classified as mechanically stable or unstable. Stable fractures include minimal and moderate compression fractures associated with an intact posterior column. Fractures associated with mechanical instability include those in which two of three columns are injured, for example, a flexion-distraction injury with disruption of the posterior and middle columns. A third category refers specifically to a burst fracture that is potentially neurologically unstable as a result of middle column failure and protrusion of bone into the spinal canal.

Treatment of these injuries has been the topic of extensive discussion in the literature, and the guidelines have developed over the last two decades.[3,4] Current recommendations depend on the type, level, severity and presence of neurological deficit. The majority of thoracolumbar fractures and fracture dislocations may be considered acute sagittal plane deformities. In both operative and nonoperative treatment, maintaining vertebral height and restoring sagittal alignment are important in the prevention of disability from back pain. Injuries that are judged stable on radiographs and have no neurological injury are usually treated using external support and mobilization. Operative treatment is used in compression

FIGURE 1A. Range of motion at DCP-screw interphase.
FIGURE 1B. Range of motion at round hole plate-screw interphase.

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Accepted for publication 20 March 2001. Received 18 December 2000.

fractures associated with >40% loss of height and/or >30 degrees kyphosis, while in burst fractures, it is used in neurologically intact or minimally involved patients with three column injuries, sublaxation in the coronal or sagittal plane, significant segmental sagittal kyphosis at fracture site, concomitant injuries or body habitus which will not allow proper brace fitting.

Criteria for choosing operative techniques for the treatment of thoracolumbar fractures remain disputed, particularly in neurologically intact patients.[5-7] Spinal instrumentation has revolutionized the operative treatment of thoracolumbar fractures and has become an essential part of the armamentarium of spinal surgeons.[8,9] The aims of internal fixation of spinal fractures are immediate stability, preservation of spine mobility, and restoration of the anatomical form of the vertebra. Unstable thoracolumbar spine injuries require stabilization to allow mobilization of the patient, relieve pain, realign the spine, and decompress directly or indirectly the neural elements. The most commonly used technique to achieve these goals is posterior spinal instrumentation.[10] Well-established techniques for posterior spinal instrumentation include rod-hook, rod-screw, and plate-screw systems.

Of the various spinal instrumentation systems and techniques introduced over the last two decades, unsegmental types of fixation such as Harrington and Luque systems gave way to more segmental types of fixation such as transpedicular screw-plate and screw-rod constructs.[11,12] Segmental instrumentation using transpedicular screws has become popular since its introduction by Roy-Camille.[13,14] Several improved systems using plates and screws have developed since then with good results.[15,16] The introduction of screw-rod constructs provided further advancement in segmental fixation of the thoracolumbar spine. Transpedicular screw-rod constructs are currently the standard in segmental fixation of the thoracolumbar spine.[17-19] The escalating cost of these systems, however, led many authors to use alternative fixation methods that are more cost effective. Several authors have successfully used locally made plates, AO plates, and dynamic compression (DCP) plates along with 6.5 mm cancellous screws for posterior transpedicular fixation of the thoracolumbar spine in a variety of pathological conditions.[20-22] In this paper we report our experience using round hole bone plates along with cancellous screws for transpedicular fixation of unstable fractures around the thoracolumbar junction. Unlike the oval hole of a DCP plate, the round hole of a round hole bone plate allows minimal movement at the plate-screw interphase and this provides a more angle-stable construct that offers more stability in the sagittal plane (Figure 1). Our objective was to determine the clinical, radiologic, and functional status of patients who underwent posterior fracture fixation using round hole bone plates and the construct's ability to maintain reduction of the fracture.

FIGURE 2A. Preoperative plain radiograph showing the fractured L-1 vertebra.

FIGURE 2B. Final follow-up radiograph at 8 months shows maintenance of spinal alignment.

## Patients and Methods

This study was a prospective follow-up of 17 patients who underwent posterior spinal instrumentation using round hole bone plates, done in the period between September 1999 and January 2000 at our institute. The indication for surgery in these patients was spinal instability due to vertebral fractures around the thoracolumbar junction. Included in this study were patients with an isolated fracture of the last thoracic or first lumbar vertebra requiring operative treatment, no other vertebral injuries, no neurologic deficit, adequate bone stock, adequate pedicle size for the insertion of 6.5 mm cancellous screws, and no mental or physical illnesses precluding the use of a thoracolumbosacral orthosis (TLSO) postoperatively. Preoperatively, all patients were kept on bed rest with spinal precautions, received adequate painkillers and subcutaneous heparin as prophylaxis against deep venous thrombosis. Preoperative radiological investigations of the vertebral column included anteroposterior (AP) and lateral plain radiographs of the entire vertebral column as well as a complete cervical spine series, including AP, lateral, and open mouth views. Computerized axial tomograph (CAT) scans were also obtained preoperatively on all patients. All patients were taken to the operating room as soon as their medical condition was stable, usually on the first elective list. They were given prophylactic antibiotics pre- and postoperatively. Using a standard posterior approach, the surgical procedure consisted of posterolateral intertransverse process fusion using autogenous iliac crest bone graft and posterior spinal instrumentation one level above and one level below the fractured vertebra. The implants used for instrumenting the spine consisted of 6.5 mm fully threaded cancellous bone screws inserted into the pedicle and round hole bone plates (Figure 2). All surgeries were performed by the same surgical team and using the same instruments and type of implants. The C-arm image intensifier was used in all cases. Postoperatively, all patients had AP and lateral radiographs of the instrumented levels on the first postoperative day. They were fitted with a TLSO brace and allowed to ambulate with physiotherapy assistance on the second postoperative day. All patients were discharged from the hospital in a TLSO brace and were followed in the outpatient clinic on a regular basis. Serial structured interviews, clinical and radiological examinations were used to assess wound healing, fusion of the instrumented levels, implant failure, and presence of back pain or radiculopathy. The kyphosis angle, vertebral body height, any displacement or scoliosis was measured on all

preoperative, immediate postoperative and final follow-up plain radiographs. CAT scans were not obtained as a part of the postoperative routine in these patients.

Vertebral fractures were classified according to the Dennis classification system that divides the vertebral column into three columns.[23,24] Stable injuries included minimal and moderate compression fractures associated with an intact posterior column. Injuries associated with mechanical instability included those in which two of three columns were injured, for example, a flexion-distraction injury with disruption of the posterior and middle columns. A third category referred specifically to a burst fracture that is potentially neurologically unstable as a result of middle column failure and protrusion of bone into the spinal canal. Operative treatment was used in compression fractures associated with >40-50% loss of height and/or >20-30 degrees kyphosis, while in burst fractures, it was used in neurologically intact patients with three-column injuries, sublaxation in the coronal or sagittal plane, or significant segmental sagittal kyphosis at fracture site.

## Results

Seventeen patients were included in this study, 11 males and 6 females. Their mean age was 34 years (range 24 to 54). Three patients (18%) had premorbid medical conditions, including two with diabetes mellitus and one with hypertension. The cause of the vertebral fracture was falling from height in 8 patients and road traffic accidents in the other 9. The fractured vertebra was L-1 in 12 patients and T-12 in the remaining 5. In 6 patients, the spinal injury was the only injury, while other injuries were sustained in the remaining 11 patients, including calcaneal fractures in 5, long bone fractures in 6, and pelvic fractures in 2 patients. Five out of those 11 patients had surgical treatment for their extremity fractures. In all 17 patients, the type of spinal fracture sustained was a burst type fracture with involvement of all 3 columns. The mean kyphosis angle was 34° (range 26° to 45°). The mean percentage loss of vertebral body height was 51% (range 40 to 60). The mean percentage loss in the cross-sectional area of the spinal canal was 24% (range 15 to 30). None of these patients had a neurologic deficit as a result of the injury. All patients underwent surgical treatment for their spinal fracture as outlined above. Postoperative complications included a subcutaneous hematoma in one patient, and a superficial wound infection in another one. Both were treated conservatively. A third patient complained of anterior thigh pain in the first few days after surgery. A CAT scan showed proper placement of the screws within the pedicles and no compression on the thecal sac or nerve roots. His pain resolved spontaneously after two weeks.

All 17 patients were followed up regularly. None was lost to follow-up. The mean duration to final follow-up was 10 months (range 5 to 12). No patient complained of chronic back pain. None had difficulty with bowel or bladder function, and none developed radiculopathy. All patients had radiographic evidence of fusion at a mean of 5 months (range 4 to 7). None had breakage or loosening of the screws and none had breakage of the plate.

The mean kyphosis angle at the fracture site was 34° preoperatively, -4° in the immediate postoperative period, and 3° on final follow-up radiograph. The percentage loss of anterior vertebral body height was 51% preoperatively; 15% in the immediate postoperative period, and 16% on final follow-up radiographs (Table 1).

## Discussion

In considering the surgical treatment of thoracolumbar fractures, the best long-term functional results are obtained with correction and maintenance of spinal alignment and preservation of motion segments.[1] These goals can be achieved in the majority of patients through the use of posterior spinal instrumentation.[25] Long unsegmental instrumentation and fusion seem to lead to persistent complaints of back pain. For example, the Harrington distraction rods improve vertebral height but produce loss of lumbar lordosis. The Luque rods do not restore vertebral height and are only moderately effective in restoring lumbar lordosis. On the other hand, short rigid instrumentation (e.g., transpedicular device) is best in accomplishing shorter fusion, maintaining vertebral height, and restoring sagittal alignment. Internal fixation using pedicle screw systems has become widely accepted as the method of choice in the surgical treatment of thoracolumbar fractures that are managed by posterior fusion and instrumentation.

In an attempt to contain the high cost of commercially available pedicle screw systems, many authors have resorted to the use of unconventional alternatives for short segmental fixation of the spine. Bhojraj and Archik successfully used locally made bone plates with semi-rigid screw-plate interphase in 20 patients with spinal instability due to a variety of causes. They reported 100% fusion rate at five months, with no incidence of implant breakage, and one case of screw loosening.[20] Louis et al. reported excellent results in 56 patients who underwent posterior spinal instrumentation using the semi-rigid Louis plate at a minimum follow-up of 2 years.[15] Thalgott et al. used AO DCP plates as spinal implants with pedicle fixation using 6.5 mm, full-threaded cancellous bone screws in 46 patients with degenerative instability of the lumbar spine followed for a mean of 1.25 years. They reported 5 cases of screw loosening, 3 cases of screw breakage, and 3 cases of screw impingement upon a nerve.[21] Several other authors have reported on the successful use of DCP plates for spinal arthrodesis.[22,26]

Semi-rigid constructs such as the DCP plate provide 3-point support for the instrumented segment. They allow for

angle variability that leads to an easier insertion of the screw into the pedicle. This variability, however, allows for a larger range of motion, especially in the sagittal plane, and this provides little resistance against kyphosing forces. Because restoring sagittal alignment and maintaining it is essential for the successful outcome of vertebral fractures, we resorted to the use of round hole bone plates along with 6.5 mm cancellous screws inserted into the pedicles. This construct provides better stability in the sagittal plane, is easy to use, cost effective and widely available. It is effective in the surgical treatment of fractures around the thoracolumbar junction and when used along with a TLSO, it leads to stable healing of the spine in its anatomic form. The major limitation of any plate-screw construct, including the one presented here, is its inability to provide distraction and hence its limited reduction capabilities. Although there is some loss of reduction when compared with more rigid conventional pedicle screw systems, there is no functional compromise in those patients.

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