Original Article

Neurosurgery

Surgical Outcome of Thoracic and Thoraco-lumbar Injuries of the Spine: A Case For Posterior Instrumentation

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ABSTRACT

Background: Management of unstable thoracic spine fractures remains controversial. The results of treatment of injuries of the thoracic and thoraco-lumbar spine with neurological involvement have been evaluated. Advantage of pedicle screw fixation are that neural canal dissection is not required and hence potential neural element injury by intracanal instrumentation avoided.

Objectives: To evaluate outcome of pedicle screw fixation and bony fusion for the surgical management of traumatic thoracic and lumbar spine fractures, their respective performance and complication rates.

Study Design:

Place and Duration of Study: This study was carried out in the Department of Neurosurgery at Assir Central Hospital Abha KSA from January 2003 to December 2004.

Materials and Methods: Twenty one patients with 32 individual vertebral injury levels (T2–L4) treated conservatively or with transpedicular spinal stabilization and bone fusion were evaluated during a 2-year consecutive period. Male: female ratio was 15:6(2.5:1)

Results: A total of 42 pedicle screws were placed from T2-L4 levels. Fracture healing and radiographic stabilization occurred at an average of 4.8 months after the initial operation. Of the patients treated conservatively, (5)35% showed significant neurological improvement compared to (6)38% of those treated surgically, but the latter group contained a much higher proportion of incomplete lesions with a far better prognosis. There were no reported cases of hardware failure, loss of reduction, or painful hardware removal.

Conclusions: These results provide evidence that with appropriate preoperative radiographic evaluation of pedicular size and orientation using computed tomography, transpedicular instrumentation is a safe and effective alternative in the treatment of unstable thoraco-lumbar (T2–L4) spinal injuries. The place for early operation might be still further restricted.

Key Words: Thoracic and Lumbar Spine Fractures, pedicle screw Fixation, surgical outcome.

INTRODUCTION

The National Spinal Cord Injury Registry, established by Ducker and Perot, reported that 40% of spinal injuries were caused by motor vehicle accidents[1,2], 20% by falls, and 40% by gunshot wounds[3], sporting accidents[4], industrial accidents, and agricultural accidents combined. It can also be the result of child abuse[5].

The treatment of traumatic fractures of the thoracic and lumbar spine remains controversial. Dorsolumbar trauma is the most common cause of paraparesis or paraplegia. Optimal goals of the management include establishment of a painless, balanced and stable spinal column with vertebral fusion. Fall from height is the most common cause of dorsolumbar fractures with majority affected belonging to young population and have significant neurological deficits, thus causing high economic burden on the society. Transpedicular instrumentation is among many options, which provides rigid fixation for upper, middle, and lower unstable thoracic and lumbar spine injuries and produces early pain-free fusion results.

Operative treatment of thoracolumbar burst fractures or fracture dislocations is a relatively modern development. There is insufficient evidence in the literature to choose between the various surgical options. In absence of conclusive studies, a prospective study of posterior instrumentation was carried out by us to obtain more convincing information regarding effectiveness of this modality.

MATERIALS AND METHODS

The results of surgical management and outcome of 21 patients admitted during a 2-year consecutive admissions (January 2003-December 2004) with thoracic and thoraco-lumbar spine trauma and neurological deficit in the Department of Neurosurgery at Assir Central Hospital Abha KSA are presented. Eleven patients received surgical treatment and ten conservative. There were 15 male and six female (ratio 2.5:1) with a follow up period of one year.

RESULTS

Twenty one (21) cases with thoracic and thoraco-lumbar spine trauma(T2-L4) were included in this study (Table 1).

Inclusion Criteria: All patients with complete or incomplete paraplegia and thoracic or lumbar acute traumatic fractures were included in this study. Also included in the study were patients with no neurological deficits (neurologically normal) who had radiographic evidence of mechanical instability associated with their burst fractures, consisting of one or more of the following: 1) greater than 50% loss of vertebral height as measured on lateral radiography; 2) more than 20° of kyphosis also measured on lateral radiography; and 3) greater than 40% canal encroachment as seen on axial computerized tomography (CT).

Age Incidence: Age range was from 15-42(mean 27)

Sex Incidence: There were 15 male and six female (ratio 2.5:1).

Clinical Features/Etiology: Road traffic accidents (RTA-12 patients), fall from height (7) and sport injuries(2) were the dominant etiologies of dorsolumbar fractures in our study with majority affected belonging to young population. The cauda equina patients were admitted with asymmetrical saddle anesthesia, radiating pain, and sphincter disturbances.

Level of Injury: Level of injury was (D2:1,D6:1,D7:1,D9:1,D10:2,D11:3 D12:4, L1:3, L2:3, and L4 :2).Most common site of involvement was from D11-L1(10 cases),D2-D10(6 cases)and lastly from L2-L4(5 cases) while all patients have TLICS score>4 (Table 1).

Table No.1: Thoracolumber injury classification and severity scores (TLICS-TLISS)

Morphology	
Compression	(1 point)
Burst	(1 point)
Translation / rotation	(3 points)
Distraction	(4 points)
Posterior ligamentous complex	
Intact	(o point)
Suspected/indeterminate	(2 points)
Injured	(3 points)
Neurologic Status	
Intact (ASIA-E)	(0 point)
Never root	(2 points)
Cord/conus	
Completed (ASIA-A)	(2 points)
Incomplete(ASIA-B,C,D)	(3 points)
Cauda equine	(3 points)
NB: A score of ≤ 3 indicates non-operative treatment ≥5 indicates operative treatment.	

Nature of Injury/Neurologic status: Radiologic workup (Figure1), included plain X-rays, CT, CT-myelo, MRI Electromyography and Nerve conduction studies. In 15 cases, fracture/dislocation was the cause, 4 cases had compression injury but no osteoporotic fracture was present. Rest of two cases had intervertebral discs in which prolapsed pieces of disc material were impinging upon the spinal cord . Radiographic measurements included: sagittal index, and compression percentage. Seven of them presented with complete paraplegia while 14 with incomplete neurological deficit as a result of partial injury to the cord or cauda equina. Ten patients had power grade of 3/5 with intact sensation and partial sphincter function. Rest of the cases had power Grade 2/5 and some degree of sensory and sphincter dysfunction. Five Lower lumbar fractures (L2-L4) presented with solitary root deficits (two) and cauda equine syndrome(three) due to massive disk herniation or fracture-dislocations . An injury severity score (thoracolumbar injury classification and severity score, or TLICS) was >5. This facilitated communication between physicians and served as a guideline for treating these injuries where a score ≤3 indicates conservative treatment and a score of ≥5 indicates operative treatment (Table 1).

Table No.2. Patient's Data

Sex	Male	15
	Female	06
Level	Dorsal	13
	Lumbar	08
Pathology	Compression	04
	Fracture dislocation	15
	Disc prolapse	02
Neurology	Complete paraglegia	07
	Incomplete deficit	14
Group	Surgical	11
	Conservative	10

Table No.3: ASIA Impairment scale

ASIA impairment scale
A: no motor or sensory function is preserved below the neurologic level of injury extending through the sacral segments S4-S5.
B: Sensory function, but not motor function, is preserved below the neurologic level of injury and extends through the sacral segments S4-S5.
C: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neuralgic level have a muscle grade of less than 3.
D: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neuralgic level have a muscle grade of less than 3 or higher.
E: Normal motor and sensory function are preserved.

Management: All patients (Table 2) underwent a complete clinical and hemodynamic evaluation on arrival, and were neurologically examined once they were hemo-dynamically stable and the airway was intact. Four patients died within 48 hrs of admission out of which two were due to associated head injuries. They were excluded from the study. Additional injuries were common: 30% of the patients had cranio-cerebral injuries and 20% were polytraumatised.

Table No.4: Function based Outcome of operated patients

ASIA Impairment Scale	Pre op	Post op	Conservative / (improved)
A	2	2	5(5)
B	2	1	0(0)
C	4	3	2(2)
D	3	3	3(2)
E	0	2	0(0)

Within 8 hours following injury, all patients with spinal cord injuries received intravenous methylprednisolone at 30 mg/kg in a bolus, followed by infusion at 5.4 mg/kg/h for 23 hours. Initial neurologic examination was made difficult due to Multiple traumatic injuries, spinal shock, or sedation.

Documentation of any neurologic deficit was made according to the American Spinal Injury Association (ASIA) Impairment Scale (Table 3). Plain X-rays of thoracic and lumbar spine, Antero-posterior and Lateral views, CT scan and MRI of the level of injury were obtained . Ten patients on conservative protocol were placed in a thoracolumbar orthosis (TLSO) with restriction of activities. After 3-4 months and when flexion extension radiographs showed no movement and deformity had not progressed, orthosis was weaned over several week. and physical therapy started. If abnormal motion was present, the deformity progressed, or severe pain persisted, surgical option was taken .All patients had posterior approach and pedical screw fixation(Figure 2). In Three patients Neuronavigation was very vital in introducing the pedicle screws safely.

B: Sensory function, but not motor function, is preserved below the neurologic level of injury and extends through the sacral segments S4-S5.

C: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neuralgic level have a muscle grade of less than 3.

D: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neuralgic level have a muscle grade of less than 3 or higher.

E: Normal motor and sensory function are preserved.

Neurological improvement was seen more frequently after early than after delayed surgery but the difference was not statistically significant.

Imobilization time was significantly reduced with surgery for the neurologically normal or minimally damaged patients, but not for completely or incompletely paraplegic patients. Postoperative back pain occurred in 11 patients. Complications directly due to the surgery were rare.

Clinical examination and plain radiographs were used to determine the presence of a solid fusion. Only two patients treated conservatively first required a delayed spinal fusion for suspected instability.

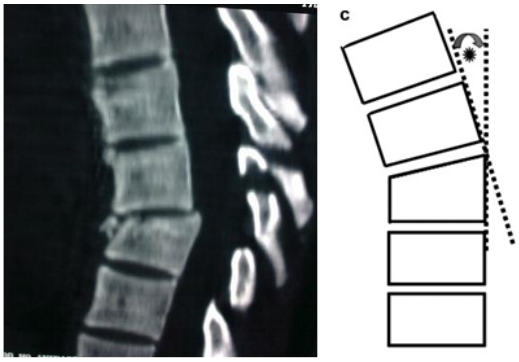

Figure No.1: CT L-S spine sagittal reformation ,L1 compression fracture and calculation of kyphotic angle.

Figure No.2: X-ray T L Spine Lateral view showing Posterior instrumentation at T11-L2 level

Postoperative Neurological Function: No patient in this study suffered further neurological deterioration (Table 4). Of the 11 patients in the surgical group, none was intact (ASIA Scale E) prior to surgery ; None of the 2 patients with a complete motor and sensory myelopathy (ASIA Grade A) recovered any function below the level of injury. Two patients were ASIA Grade B preoperatively; one of them improved to Grade C. Four patients were ASIA Scale C preoperatively; 2 of them improved to Grade D. Three patients were ASIA Grade D preoperatively; two of whom improved to Grade E postoperatively.

Therefore, of the nine incompletely paraplegic patients, five patients improved one ASIA grade postoperatively. With regard to pain, 35% of the patients having posterior decompression and fixation had either none or

minimal pain .With regard to work, 50% of the surgical patients and 90% of the conservative group(with mild to moderate deficits only) returned to their previous employment or new employment which consisted of heavy labor.

In the surgical group, the mean kyphotic deformities measurements (fig. 1) preoperatively, immediately postoperatively, and at final follow up respectively were 16.5° (± 7.5°), 6.3° (± 6.2°), and 7.5° (± 7.0°).Same figures in conservative group were pretreatment 15.7(± 7.0°), and post treatment 8.8° (± 7.7°) making surgical group much better improvement wise.

Hence preoperative mean kyphotic deformity was 16.5°, whereas the mean follow-up was 7.5° (P < 0.001). The mean final correction of sagittal index achieved was 8.9°, or a 54.0% improvement.

DISCUSSION

This article evaluates the management outcome of acute dorsolumbar vertebral fractures managed by posterior instrumentation.

More than 150,000 persons in North America sustain fractures of the vertebral column each year (6). The thoracolumbar and lumbar spine are the most common sites for fractures because of the high mobility of the lumbar spine compared to the more rigid thoracic spine. Injury to the cord or cauda equina occurs in approximately 10-38% of adult thoracolumbar fractures and in 50-60% of fracture dislocations. The rate of bony injury without neurologic complication is higher (7). A high percentage of lumbosacral fractures occur in individuals younger than 30 years. Nearly 60% of patients have serious disabling deficits. Heavy economic burden of spine fractures on the society was by Van der Roer et al[8].

Indications: The surgical approach is determined by the level of injury, characteristics of the fracture, and location of the neural compression. Any type of instrumentation will fail unless the spine is supported by a solid bony fusion. In a complete neurologic deficit (paraplegia or tetraplegia) which does not improve within 48 hours, decompressive surgery is not indicated. Patients with cauda equina or incomplete cord injury benefit from decompressive surgery even after long delays. Patients with nerve root compression at the lumbosacral region achieve better outcomes following surgical decompression.

The timing of decompressive surgery and its effects on the rate of neurologic recovery also has remained unclear[9,10]. Early spine fixation (within 48 hours) reduced morbidity and was cost-effective[11].

Anterior surgery did not prove superior to posterior procedures and was difficult in approach. The posterior approach with interpedicular screws and rods for segment stabilization was found appropriate method. In carefully selected instances, pedicle screw fixation of upper, middle, and lower thoracic and upper thoracolumbar spinal injuries is a reliable and safe method of posterior spinal stabilization as it offer superior three-column control in the absence of posterior element integrity.

Compression fractures have a disrupted anterior and intact middle column. A compression of more than 40% of the anterior vertebral wall or a kyphotic deformity of more than 25° is treated surgically.

In burst fractures, both the anterior and middle columns are disrupted[12,13]. If the canal compromise is more than 40% with neurologic deterioration, surgical intervention may be required[26]. In patients with burst fractures and significant posterior column disruption, anterior and posterior fusion (360°) is indicated[14,15,16,17] .

In patients with fracture-dislocation injuries, all 3 columns of the spine are disrupted with a high incidence of spinal cord injury and require surgical treatment.

Surgical intervention is often necessary in patients with unstable fractures or neurologic deficits related to compression of the neural structures by bony elements or hematomas, partial cord injuries, or cauda equina injuries[18,19].

The technique of pedicle fixation requires a thorough knowledge of the pedicle anatomy[20]. Internal fixation combined with spinal fusion uses titanium rods longitudinally anchored to the spine by transpedicular screws. Powerful forces can be applied to the spine through these implants to correct deformity. Indirect decompression can be done with the aid of distraction forces, attributed to the ligamentotaxis of the posterior longitudinal ligament[21,22,23], more appropriately termed "annulotaxis,"[24] because the fibers that reduce the intracanal fragments were found to originate mainly in the annulus of the superior vertebra. Numerous clinical and experimental studies demonstrate higher fusion rates in patients with transpedicular fixation.

Although various implants are available, pedicle fixation systems are the most commonly used implant type in the dorsolumbar spine. The large size of the lumbar pedicles minimizes the number of instrumented motion segments required to achieve adequate stabilization.

The fusion is evaluated with plain radiographs, including flexion and extension views, at 6 weeks, 3 months, and 6 months postoperatively. If in doubt, a CT scan is performed.

Overall risk of neurologic deterioration with posterior instrumentation is 1-3%. Postoperative neurologic

deterioration occurs from graft dislodgment, displacement of the hardware, or hematomas.

Future: Morphogenetic bone proteins type 2(BMP-2) and acidic and basic fibroblast growth factors are effective in promoting bone formation and fusion. Studies performed using BMP-2 have yielded high rate of fusion but with but still costly[25].

CONCLUSION

RTA and Fall from height are the most common causes of dorsolumbar and lumbar spine fractures with majority affected belonging to young population and had major neurological deficits, thus causing significant economic burden on the society.

We conclude that pedicle screws fixation is a safe, reliable, cost effective technique with favorable results in acute polytrauma and helps in early mobilization and rehabilitation, thus facilitating possible neurological recovery.

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