Surgical Neurology International

SNI: Spine, a supplement to Surgical Neurology International

OPEN ACCESS

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Editor: Nancy E. Epstein, MD Winthrop University Hospital, Mineola, NY, USA

Neurological outcome in a series of 58 patients operated for traumatic thoracolumbar spinal cord injuries

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Received: 16 October 13 Accepted: 06 March 14 Published: 28 August 14

This article may be cited as:
Dobran M, Iacoangeli M, Di Somma LM, Rienzo AD, Colasanti R, Nocchi N, *et al.* Neurological outcome in a series of 58 patients operated for traumatic thoracolumbar spinal cord injuries. Surg Neurol Int 2014;5:S329-32.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2014/5/8/329/139645

Abstract

Background: Traumatic thoracolumbar spinal fractures represent approximately 65% of all traumatic spinal fractures and are frequently associated to permanent disability with significant social and economic impact. These injuries create severe physical limitations depending on neurological status, level of fracture, severity of injury, patient age and comorbidities. Predicting neurological improvement in patients with traumatic spinal cord injuries (SCIs) is very difficult because it is related to different preoperative prognostic factors. We evaluated the neurological improvement related to the preoperative neurological conditions and the anatomic level of spinal cord injury.

Methods: From January 2004 to June 2010, we operated 207 patients for unstable thoracolumbar spinal fractures. We carried out a retrospective analysis of 69 patients with traumatic SCIs operated on by a posterior fixation performed within 24 hours from the trauma. The preoperative neurological conditions (ASIA grade), the type of the fracture, the anatomic level of spinal cord injury and the postoperative neurological improvement were evaluated for each patient.

Results: The ASIA grade at admission (P = 0,0005), the fracture type according to the AO spine classification (P = 0,0002), and the anatomic location of the injury (P = 0,0213) represented predictive factors of neurological improvement at univariate analysis. The preoperative neurological status (P = 0,0491) and the fracture type (P = 0,049) confirmed a positive predictive value also in the multivariate analysis.

Conclusions: Our study confirms that the preoperative neurological status, the fracture type and the anatomic location of the fracture are predictive factors of the neurological outcome in patients with spinal cord injury.

Key Words: Neurologic recovery, pedicle screw fixation, spinal cord injury, thoracolumbar fractures, thoracic spine fractures

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.139645

Quick Response Code:

INTRODUCTION

Much progress has been made in the research of spinal cord injuries (SCIs). The new biological treatments, including cell transplantation and gene therapy, provide the solid theoretical foundation for future clinical application. Nevertheless, despite the technological progress in the treatment of spinal fractures, outcomes of surgery remain unpredictable.

Differentiating improvement rates based upon the degree of preoperative neurological dysfunction and the location/level of the lesion have been most closely correlated with the extent of predictable postoperative improvement. The understanding of the mechanism of neurological damage and the optimal surgical choices are critical to achieving the best results following surgery in patients with SCIs.

MATERIALS AND METHODS

From January 2004 to June 2010, 69 patients with traumatic SCIs and neurological deficits were operated at our Institute for unstable thoracolumbar spinal fractures and submitted to a retrospective analysis. A complete neurological follow-up was made in 58 patients (39 males and 19 females). Patients' age ranged from 15 to 85 years (average of 47.46 years).

Falls from height represented the main cause of SCIs in our patients (58.7%), followed by motorcycle and car accidents.

At admission, all patients were managed according to NASCIS III protocol. Spine surgery was performed as soon as the patient's medical conditions allowed it.

Surgical treatment of these fractures was indicated in case of neurological impairment, severe spinal deformity (canal encroachment >50%, vertebral body wedging >60%, kyphosis >25°) and instability. All patients were submitted to decompression of spinal cord and spinal stabilization through posterior approach with screws and rods within 24 h since trauma.

Pre- and postoperative clinical evaluation were performed according to the American Spinal Injury Association (ASIA) grading system. ASIA grade at admission is illustrated in Table 1.

All patients were preoperatively evaluated with X-ray, computed tomography (CT) scan, and, in selected cases, magnetic resonance imaging (MRI) allowing a fracture classification according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO spine system). Injury location was thoracic (T4-T9) in 11 patients (18.96%), thoracolumbar (T10-T12) in 21 (36.21%), and lumbar (L1-S1) in 26 (44.83%). According to the AO spine fracture classification, we observed 41 type A (70.69%), 5 type B (8.62%), and 12 (20.7%) type C [Table 2].

Correct screws placement and spinal canal realignment were confirmed by a postoperative CT scan.

Demographic data, injury, and treatment details were recorded. The univariate analysis of data was performed using the Chi-square test for discrete variables, the Mann–Whitney test for the continuous ones and the logistic regression for the multivariate analysis.

RESULTS

In our series, a clinical postoperative evaluation in patients with neurological impairment was performed. ASIA grade at 1 year follow-up was A in 11 patients (19%), B in 5 (8.62%), C in 9 (15.5%), D in 11 (19%), E in 22 (37.9%) as shown in Table 3. Forty-two patients (72.4%) had improvement in neurologic function at 1-year follow up. In particular, a neurological improvement of one or more ASIA level was observed in 6 patients (35.29%) of ASIA A (3 B, 2 C, 1 D), in 9 (81.82%) of ASIA B (5 C,3 D,1 E), in 8 (80%) of ASIA C (6 D, 2 E), and in 19 (95%) of ASIA D ($P = 0.0005$) [Table 3]. No patient worsened neurologically at 1-year follow up. Only 25% of patients with type C fracture showed neurological improvement, compared with 85.36% of patients with type A fracture; patients with type B fracture had a 80% improvement rate ($P = 0.0002$) [Table 4]. Patients with lumbar region injuries had neurological improvement at a rate of 88.46%, versus 45.45% and 66.6%, respectively, for patients with thoracic and thoracolumbar region injuries ($P = 0.0213$) [Table 5].

Age was not significantly related to neurologic improvement ($P = 0.2138$). ASIA grade at admission ($P = 0.0491$) and the fracture type according to the AO spine classification system ($P = 0.049$) represented independent predictive factors of the neurological improvement in the multivariate analysis.

Table 1: Neurological status at admission

Admit ASIA (%)	Number of patients
A	17 (29.31)
B	11 (18.97)
C	10 (17.24)
D	20 (34.48)

ASIA: American Spinal Injury Association

Table 2: Levels and type (according to the AO spine classification) of thoracolumbar fractures

AO/magerl classification		Fracture's level	
A	41	(T4-T9)	11
B	5	(T10-T12)	21
C	12	(L1-S1)	26

Table 3: Neurological status at admission and at 1-year follow-up

Admit ASIA (improvements)	1 year ASIA				
	A	B	C	D	E
A (6/17)	11	3	2	1	0
B (9/11)	0	2	5	3	1
C (8/10)	0	0	2	6	2
D (19/20)	0	0	0	1	19

ASIA: American Spinal Injury Association

Table 4: Neurological status at 1-year follow-up in relation to the fracture type according to the AO spine classification

AO/Magerl classification (improvement)	1 year ASIA					
	Admit ASIA	A	B	C	D	E
A (35/41)	A	2	2	1	1	0
	B	0	2	4	1	1
	C	0	0	1	5	2
	D	0	0	0	1	18
B (4/5)	A	1	0	1	0	0
	B	0	0	0	1	0
	C	0	0	0	1	0
	D	0	0	0	0	1
C (3/12)	A	8	1	0	0	0
	B	0	0	1	1	0
	C	0	0	1	0	0
	D	0	0	0	0	0

ASIA: American Spinal Injury Association

Table 5: Neurological status at 1-year follow-up in relation to the anatomic location of the injury

Level (improvement)	1 year ASIA					
	Admit ASIA	A	B	C	D	E
T4-T9 (5/11)	A	5	2	0	1	0
	B	0	0	1	0	0
	C	0	0	1	1	0
	D	0	0	0	0	0
T10-T12 (14/21)	A	5	1	2	0	0
	B	0	2	2	1	1
	C	0	0	0	1	1
	D	0	0	0	0	5
L1-S1 (23/26)	A	1	0	0	0	0
	B	0	0	2	2	0
	C	0	0	1	4	1
	D	0	0	0	1	14

ASIA: American Spinal Injury Association

Complications were hardware failure with repositioning of the screws in five patients (3.7%), wound infection in six cases (4.44%), and cerebrospinal fluid (CSF) leak in three patients (2.22%) with complete resolution after antibiotic therapy and subdural drainage, respectively.

DISCUSSION

Traumatic thoracolumbar spine fractures are an important cause of morbidity and mortality in young population. These injuries create severe physical limitations, which depend on the neurological level, severity of injury, and medical comorbidities. The personal and financial cost of acute and rehabilitative medical care for these patients are substantial.[1,2] Predicting neurological improvement is difficult and there are few reports in literature about the prognostic factors in spinal-injured patients.

Literature reports a range of recovery of neurological deficit of about 50-85% of early operated patients.[3] In our series of thoracolumbar SCIs, 72.4% of patients neurologically improved one or more ASIA level after surgery compared with the neurological status at admission. According to literature, this improvement suggests that an early surgical decompression of spinal cord (<24 h since trauma) and posterior stabilization maximize the opportunity of neurological recovery.[4] In fact the initial mechanical trauma, secondary to traction and compression forces, primarily damages the central gray matter with subsequent involvement of the white matter within 72 h after the injury.[5] Therefore in case of spinal compression a reduction of the secondary damage by means of an early decompression is mandatory.[4] Anyway neurological improvement seems to be correlated with ASIA grade at admission with best results in patients with ASIA grade D and worst results in patients with ASIA grade A.[6]

Since the risk of neural injury is largely linked to the degree of thoracolumbar fractures instability, it does not surprise that the prognosis of type C fractures is the worst, followed by that of type B and A.

In fact in our series, only 25% of patients with type C fractures showed neurological improvement compared with 85.36% of patients with type A and with 80% of those with type B.

In type C fractures (anterior and posterior element injuries with rotation), a neural injury is caused by the fragments dislocated into the spinal canal and by its encroachment due to translational displacement. The energy dissipated to the neural elements at the time of injury may be a consequence of the dynamic canal encroachment.[7] The relation between the spinal canal diameter and its association with neurological sequelae after trauma has been cited several times in literature but the problem is still open.[7] While in the cervical spine, a larger sagittal diameter protects the spinal cord, many authors see no such correlation in the thoracolumbar spine.[7]

According to some authors, neurological improvement rates after thoracic, thoracolumbar, and lumbar SCIs may be correlated with the level of injury according to the blood supply and the cells anatomy of the spine.[5]

For example, T1-T5 fractures cause often complete neurological lesions with low potential improvement due to the poor blood supply in this region and the high energy mechanism needed to create injury in consideration of the great stability of the chest wall and spinal column.[5]

Instead, patients with lumbar SCIs have a greater opportunity for neural recovery and it is most likely due to the greater proportion of lower to upper motor neurons

in this region and the possibility for "root escape" as well as on the increased lower motor neuron ability to self repair. Moreover, Marino *et al*. demonstrated, through serial single fiber electromyography examination, that the improvement of the motor level in complete quadriplegia is due in part to peripheral nerve sprouting.[8]

In our series, 60% of lumbar level patients with motor complete injuries improved compared with the 44% of thoracic level patients with motor complete damage.[9] These data were significant in the univariate analyses, but not in the multivariate one. In our patients, age was not significantly related to neurological improvement as reported in literature.

CONCLUSIONS

None of our patients deteriorated after surgery. In most cases, we have used short pedicle instrumentation that minimizes blood loss, time surgery, and allows good stabilization for the time necessary for arthrodesis, which remains the first target for fractures healing. However, for some patients long instrumentation has been necessary in cases of fragmentation of the vertebral body and ligaments destruction.

In our study, age was not significantly related to neurological improvement ($P = 0.2138$). The ASIA grade at admission ($P = 0.0005$), the fracture type according to the AO spine classification ($P = 0.0002$) and the anatomic location of the injury (thoracic versus lumbar) ($P = 0.0213$) represent predictive factors of neurological improvement at univariate analysis. The preoperative neurological status ($P = 0.0491$) and the fracture type ($P = 0.049$) confirm a positive predictive value also in the multivariate analysis.

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