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ORIGINAL CONTRIBUTION

Efficacy of Surgical Decompression in the Setting of Complete Thoracic Spinal Cord Injury

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Abstract

Background/Objective: An assessment of neurological improvement after surgical intervention in the setting of traumatic thoracic spinal cord injury (SCI).

Methods: A retrospective evaluation of a nonconsecutive cohort of patients with a thoracic SCI from T2 to T11. The analysis included a total of 12 eligible patients. The neurologic and functional outcomes were recorded from the acute hospital admission to the most recent follow-up. Data included patient age, level of injury, neurologic examination according to the Frankel grading system, the performance of surgery, and the mechanism of the time-related SCI decompression.

Results: All patients had a complete thoracic SCI. The median interval from injury to surgery was 11 days (range, 1–36 days). Decompression, bone fusion, and instrumentation were the most common surgical procedures performed. The median length of follow-up was 18 months after surgery (range, 9–132 months). Motor functional improvement was seen in 1 patient (Frankel A to C).

Conclusion: Surgical decompression and fusion imparts no apparent benefit in terms of neurologic improvement (spinal cord) in the setting of a complete traumatic thoracic SCI. To better define the role of surgical decompression and stabilization in the setting of a complete SCI, randomized, controlled, prospective studies are necessary.

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Key Words: Spinal cord injuries, complete; Surgical decompression; Surgery, thoracic spine; Spinal fusion, thoracic

INTRODUCTION

Spinal trauma complicated by injury to the spinal cord is a devastating event on a personal and family level, as well as a tremendous financial burden to society because of its attendant morbidity, expense, and prolonged treatment requirements (1). Spinal injury occurs most frequently in young men with an average age of 35 years. The most frequent etiologies of injury are motor vehicle crashes and falls, followed by violence, sports-related injuries, and work-related accidents (2–4). Approximately 40% of patients with spinal cord injury (SCI) present with complete SCI, 40% with incomplete injury, and 20% with either no cord or only root lesions (5).

There has been a great deal of discussion as to which treatment course is most helpful in ensuring maximum neurologic improvement after an SCI (5–33). Spinal decompression in the setting of a traumatic thoracic SCI is controversial. To date, the role of decompression in patients with incomplete SCI is supported only by class 3 and limited class 2 evidence, but there is no definite evidence to support the role of decompression in complete SCI. The objective of this study was to examine the benefit of neural decompression in the setting of a complete thoracic SCI after trauma.

METHODS

Patients evaluated in this historical cohort study were all admitted to a regional level I trauma center in southeastern Iran from October 1994 through March 2005. The inclusion criteria were (a) complete neurological deficit attributable to a traumatic thoracic SCI (T2–T11); (b) at least a 6-month follow-up (9); and (c) SCI

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caused by an acute nonpenetrating traumatic event with radiographically documented spinal cord compression caused by cord encroachment by anterior vertebral body elements, disk material, or posterior vertebral elements as a result of fracture subluxation or dislocation.

The exclusion criteria were (a) Frankel grade B through E; (b) spinal cord abnormalities caused by other disease processes (eg, multiple sclerosis or pre-existing myelopathy as a result of severe spondylosis without trauma); and (c) severe cardiovascular shock. Of 108 patients who were evaluated during this period, 96 were excluded from the study because of the following reasons: neurologic examination consistent with a Frankel grade of B to E, inadequate documentation of preoperative neurologic examination, complete SCI but no compression on myelography, lost to follow-up (<6-month follow-up), penetrating injury caused by gun shot or knife injury, or isolated root or cauda equina injury. This left 12 eligible patients with complete thoracic (T2–T11) SCI.

During the prehospital and acute care phase, the following data were collected for all patients: age, sex, associated injuries, mechanism of injury, and admitting and follow-up Frankel grade. The time intervals from injury to arrival at the Khatam-ol-anbia Emergency Department and to surgical decompression were also collected. Information was obtained from medical records, radiologic studies, and patient interviews. The type of surgical procedure was also recorded.

Neurologic Evaluation

Motor and sensory examinations were performed at admission, before surgery, immediately after surgery, and at the most recent follow-up. Neurologic function was measured by 3 parameters; neurologic recovery was recorded as any improvement in (a) motor or sensory function; (b) Frankel grading system (10); or (c) motor index score. Patients were assigned an initial motor index score that included manual muscle test scores of all key muscles, sensory examination (prick and touch), sacral and deep tendon reflexes, and muscle tone evaluation. Sensory level was recorded as the most caudal dermatomal level of bilateral intact sensation. Neurologic examinations were documented on admission, daily during the acute hospitalization, and at all follow-up outpatient encounters.

Treatment

Standard spinal immobilization and resuscitation were implemented by emergency medical personnel. All patients were prescribed intravenous methylprednisolone (30 mg/kg intravenous [IV] bolus over 15 minutes followed 45 minutes later by a 5.4 mg/kg/h intravenous infusion over 23 hours) if they arrived at the emergency room within 8 hours of the accident (34). All patients underwent preoperative myelography, computerized tomography (CT) imaging, and/or magnetic resonance imaging (MRI). Patients with CT-myelography or MRI-documented spinal cord compression (from vertebral burst fractures or fracture dislocations, persistent misalignment, epidural hematoma, or intracanalicular bone fragments) underwent surgical decompression and spinal column stabilization. The standard chosen procedure was a posterior transpedicular or extracavitary decompression and instrumented fusion. Adequacy of decompression was determined by a comparison of preoperative and postoperative CT and MRI scans (35).

Data Collection

Neurologic follow-up examinations were performed at in-hospital and outpatient follow-up visits by the primary author. In cases of the deceased, the last documented neurologic examination was used. Data collected were analyzed for age, sex, number of days before surgery in the acute hospital setting, number of days to most recent follow-up, motor score on admission to the acute hospital, both preoperative and postoperative, and motor score at most recent follow-up.

Outcome Assessment

A patient was considered to have an excellent result if they became ambulatory in the household or community or had marked improvement in ambulatory status. A good outcome was recorded if there was recovery of 1 or more motor-root levels in the lower extremities or partial recovery of multiple levels. A fair result was recorded if the individual had less recovery, but at least partial improvement of 1 or 2 motor-root levels, and a poor result was no improvement.

RESULTS

There were 12 eligible patients with neurologic injury levels from T2 to T11 (Table 1). Before treatment, all patients (100.0%) had a functionally complete neurological deficit below the level of injury. Mean patient age was 26.7 ± 7.5 years; 92% were men. The most common level of injury was T5, and the most frequent mechanism of injury was motor vehicle crashes. The median time interval from injury to surgery was 11 days and ranged from 1 to 36 days. The length of follow-up ranged from 9 months to 12 years, with a median time period of 18 months (Tables 2 and 3). The primary indications for surgery were documented spinal cord compression in the setting of a neurologic complete deficit and spinal instability. Sensori-motor functional improvement was seen in 2 patients; motor functional improvement was seen in only 1 patient (Frankel A–C).

Eight complications were recorded in 5 patients, including continued cord compression from an inadequate decompression, deep wound infection, *Klebsiella* urinary tract infection, fever, bed sore, spasticity, and Amikacin-induced hearing loss. One patient with a complete T7 Frankel A SCI after a motor vehicle crash required 2 surgical procedures. An initial decompression and

Table 1. Summary of Data From 12 Individuals With Complete Thoracic Spinal Cord Injury

No.	Age (years)	Sex	Level of Injury	Mechanism	Time to Decompression (days)	Procedure	Fpre	Flate	Follow-up (months)	Result
1	24	M	T11	Not documented	Not documented	2	A	A	36	Poor
2	21	M	T5–T6	Motorcycle	Not documented	1	A	A	10	Poor
3	30	M	T5	Not documented	1	1	A	A	84	Poor
4	27	M	T11	Not documented	2	2	A	C	9	Good
5	43	M	T4–T5	Car crash	2	1	A	A	13	Poor
6	23	M	T11	Car crash	2	2	A	A	15	Poor
7	31	M	T7–T9	Car crash	11	2	A	A	20	Poor
8	21	F	T5	Car crash	11	2	A	A	18	Poor
9	25	M	T7	Car crash	25	1	A	B	44	Poor
10	17	M	T5	Motorcycle	28	4	A	A	132	Poor
11	33	M	T6	Car crash	30	3	A	A	12	Poor
12	17	M	T10	Motorcycle	36	4	A	A	132	Poor

M, male; F, female; Fpre, preoperative Frankel; Flate, the latest follow-up Frankel.
Procedures: 1, decompression and bone graft insertion was performed in all of the patients; 2, Harrington rod; 3, USS, pedicle screw; 4, 2 stages, first posterior decompressed, second instrumentation; 5, conservative without operation.

Table 2. Frequency Distribution of Some Variables in the Patients With Thoracic SCI

Variable		Frequency (%)
Sex	F	1 (8.0)
	M	45 (92.0)
Level of injury	T5	5 (31.3)
	T11	3 (18.7)
	T6	2 (12.5)
	T7	2 (12.5)
	Others	4 (25.0)
Mechanism	Car crash	6 (50.0)
	Motorcycle	3 (25.0)
	Fall	0 (0.0)
	Not documented	3 (25.0)
Surgeon	Author	8 (66.7)
	Others	4 (33.3)
Completeness	Complete	12 (100.0)
	Incomplete	0 (0.0)
Cord function	Not change	10 (83.3)
	Change	2 (16.7)
Urine incontinence improvement	Absent	10 (83.3)
	Not detected	2 (16.7)
	Complete	0 (0.0)
Result	Excellent	0 (0.0)
	Good	1 (8.3)
	Fair	0 (0.0)
	Poor	11 (91.7)

fusion procedure without instrumentation resulted in progressive kyphosis after cast removal. Twenty-two months after the initial index procedure, a revision posterior stabilization procedure was performed with instrumentation. At the 44-month follow-up, the patient was noted to have return of sensation in 1 lower extremity (Frankel B).

DISCUSSION

After spinal cord decompression, motor functional improvement was seen in only 1 patient (Frankel A–C), and sensory (without motor) improvement was seen in 1 other patient. Only 2 of 11 patients (18%) with initial adequate decompression experienced improvement of 1 grade on the Frankel or American Spinal Injury Association (ASIA) scales. One patient had an initial decompression that was later determined to be inadequate but was included in the study because of its fulfillment of the inclusion criteria of the study. Vale et al

Table 3. Mean, Median, and Range of Some Variables in the Patients With SCI

Variable	Mean ± SD	Range	No. of patients
Age	26.0 ± 7.4	17–43	12
Deduct preoperative and postoperative Frankel	0*	0–2	12
Follow-up (months)	19*	9–132	12
Time to decompression (days)	11*	1–36	10

*Median.

(36) observed that 33% of patients with a complete thoracic SCI improved at least 1 Frankel or ASIA grade. Why our results are different in terms of functional improvement is difficult to tell. It may be that the patients in the study of Vale et al were treated with aggressive blood pressure support, which may have improved the potential for neurologic improvement.

Our study showed that, in cases of complete thoracic SCI, there was no correlation between spinal cord decompression and motor improvement. In several studies, no patients with a complete neurological deficit improved after an anterior spinal decompression and fusion (13–15) or nonoperative management (16,37,38). In the opinions of these authors, emergent spinal decompression has no indication in the setting of a complete thoracic traumatic SCI.

In general, patients with a partial neurological deficit often show improved lower extremity motor and/or bladder function with either nonoperative or operative intervention (10–12,15–20,37–39).

Grootboom and Govender (14) treated the majority of their patients with injuries to the upper thoracic spine from T2 to T9 nonoperatively. All patients with a partial neurological deficit improved over time.

The review of the relevant clinical literature shows that most studies comparing decompressive surgery with conservative management fail to show any advantage of surgery in terms of neurologic improvement in the setting of a complete SCI (21–25). In the series of Tator et al (23), Bedbrook (40), and Wilmot and Hall (26), operative treatment did not seem to be superior to nonoperative treatment. Boerger et al (27) reported a meta-analysis on the value of surgical decompression in affecting neurological outcome in patients with thoracolumbar fractures. Their results showed that surgery did not offer a significant advantage compared with conservative treatment with respect to neurological outcome. Waters et al (28) showed motor recovery did not significantly differ between patients categorized in various surgical subgroups or between those having surgery and those treated nonoperatively. Geisler et al (29) concluded that the sparseness of prospective data on the treatment of traumatic SCI at 28 centers in North America suggested that treatment guidelines have limited empirical support and should be made cautiously. Bohlman and Freehafer (30) has reported that greater neurologic recovery occurs if surgical decompression is performed within 2 years after the injury.

The efficacy of decompression after SCI in enhancing neurological recovery in animal models has been widely shown (9,41–50). There are 8 prospective nonrandomized case series (class 2 evidence) (23,25,31–33,51–53) and several retrospective case series with historical controls (class 3 evidence) that have addressed the role of spinal cord decompression. None has shown an advantage to surgery in the setting of a complete SCI.

Spinal fusion with instrumentation is useful for purposes of mobilization, prevention of deformity with late pain, and less reliance on the need for cumbersome braces in the patient population with paraplegia.

Anterior thoracolumbar decompression is a useful surgical strategy in cases of trauma, infection, or tumor that causes compression of the neural tissues, resulting in an incomplete neurologic deficit (54).

In our patient population, victims of motorcycle crashes experienced more severe injury in terms of extremity trauma than those involved in motor vehicle crashes. The typical mechanism of injury after a motorcycle accident was a flexion injury to the thoracic spine (55).

Our study did not show that surgical decompression was effective in terms of neurologic improvement in the setting of complete thoracic SCI. A problem with our study is the small number of cases, which decreases the power of our study and prevents us from employing any meaningful statistical analysis. Another potential problem is that the majority of surgeries were delayed, although again, the timing of surgical decompression has not been shown in clinical trials to affect neurologic improvement. A true understanding of the role of surgical intervention in the setting of traumatic thoracic SCI can only be determined through a randomized controlled clinical trial.

CONCLUSIONS

Surgical decompression and fusion did not result in spinal cord recovery after complete SCI in the thoracic spine. Clearly, to better define the role of surgery in the management of acute SCI, randomized, controlled prospective trials are required.

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