Traumatic Central Cord Syndrome: Neurologic Recovery After Surgical Management

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Abstract

The purpose of this study was to evaluate neurologic recovery following an acute, traumatic central cord syndrome (TCCS) injury.

We retrospectively reviewed 69 patients who were treated surgically following an acute TCCS injury. The American Spinal Injury Association (ASIA) motor scores (AMS) were obtained from the time of presentation, from the time of hospital discharge, and from the most recent follow-up visit.

The mean AMS was 63.2±25.8 at presentation and 89.9±14.6 at final follow-up (*P*<.001). Overall, 74% of the patients improved at least one ASIA impairment scale grade. Surgery was performed at a mean of 2.9 days (range, 0.25-24 days) following the injury using a posterior approach in 33 patients (48%), anterior approach in 22 patients (32%), and combined anterior-posterior approach in 14 patients (20%). Neither surgical timing nor approach appears to affect motor recovery. Adverse events were encountered in 24.6% of the patients. There were no deaths.

A history of a loss of consciousness, decreased rectal tone at presentation, the presence of a fracture, the timing of surgery, and surgical approach did not have a significant impact on motor recovery.

Acute, traumatic central cord syndrome (TCCS) is the most common incomplete traumatic cervical cord injury pattern, accounting for 20% of all cervical spinal cord injuries and approximately 70% of incomplete cervical cord injuries.[1-4] In 1954, Schneider and colleagues[5] described this clinical entity as a "syndrome of acute central cervical spinal cord injury characterized by disproportionately more impairment of the upper than lower extremities, bladder dysfunction, usually urinary retention, and varying degrees of sensory loss below the level of the lesion." Although some controversy still surrounds the exact pathophysiology of central cord syndrome, recent histopathologic evidence correlating with magnetic resonance imaging findings suggests that the lateral cortical spinal tracts are where the most significant injury occurs in patients with this clinical entity.[6] Investigators have used various definitions of TCCS, but a deficit of at least 10 motor score points in the upper versus lower extremities has been used as a diagnostic criterion.[7]

In the management of TCCS, it can be difficult to predict the degree of neurologic recovery that should be expected, as some patients exhibit rapid, spontaneous neurologic improvement, whereas others continue to have significant residual neurologic disability.[1,4,8,9] Management of TCCS, especially with regard to use and timing of surgical intervention, remains controversial. Potential surgical indications include mechanical instability of the cervical spinal column and persistent, significant spinal cord compression in the setting of an incomplete cord injury.[10,11]

In patients with TCCS, a more positive neurologic outcome has been associated with multiple factors, including younger age, higher formal educational level, higher initial American Spinal Injury Association (ASIA) score, absence of medical comorbidities, and absence of spasticity.[1,2,8,12] Most studies of TCCS have combined patients treated nonsurgically with those treated surgically. To our knowledge, however, the specific factors affecting neurologic recovery in the surgically treated population have not been reported.

The primary objective of this study was to define the degree of neurologic improvement in a population of TCCS patients treated with contemporary surgical techniques and to define the complications that occurred in this population. In addition, we sought to determine if certain factors, such as loss of consciousness, poor rectal tone, presence of spine fracture, timing of surgery, and surgical approach, affected motor recovery after surgical intervention for TCCS.

Materials and Methods

After obtaining Institutional Review Board approval, we used a prospectively maintained surgical database, the Spine Outcome Study Trauma Database, to identify patients with the diagnosis of a TCCS injury pattern.

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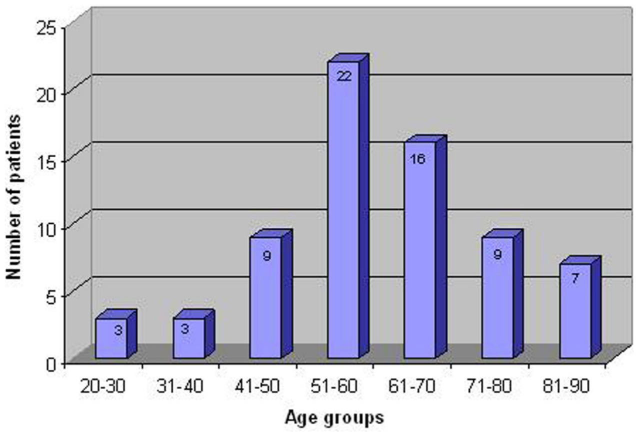

Figure 1. Histogram analysis of number of patients in specific age group.

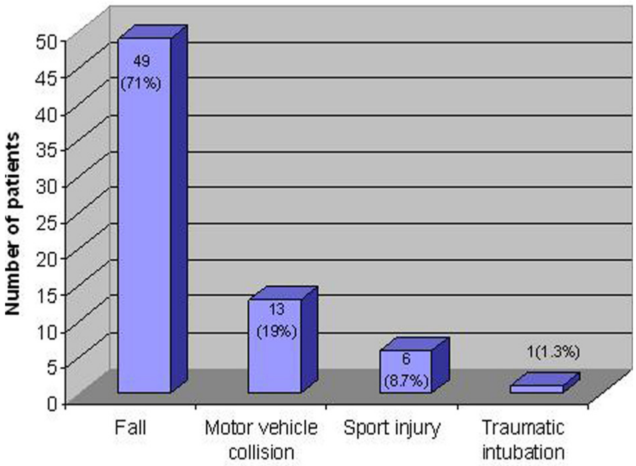

Figure 2. Mechanisms of injury.

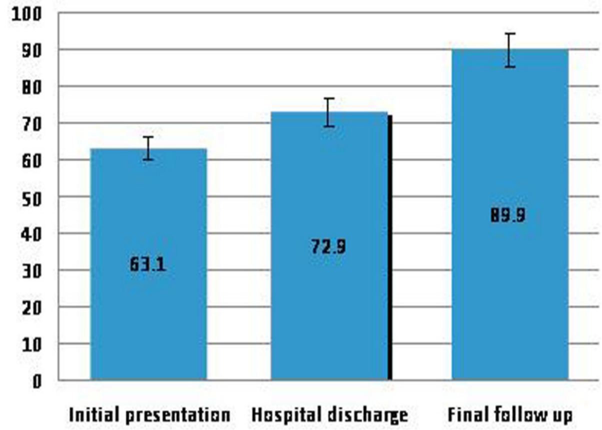

Figure 3. American Spinal Injury Association motor score.

This pattern was defined as a traumatic, incomplete cervical cord injury with a pattern of motor dysfunction showing at least 10 motor points less in the upper versus lower extremities. The indication for surgery in this study was either spinal column instability or a declining neurologic examination in the setting of severe cord compression.

We identified 1087 patients with spinal column injuries sustained between 2000 and 2009. Of these injuries, 266 were classified as TCCS. We then excluded patients with a pre-existing neurologic disease, prior cervical trauma, or an incomplete follow-up, as well as nonsurgically treated patients. Sixty-nine patients met the inclusion criteria for the study. A systematic chart review was conducted by an independent research physician to define the neurologic outcome of each patient and to determine the clinical course after the spinal cord injury.

Patient age, sex, and mechanism of injury were determined from the medical records. ASIA motor score (AMS)[13] was obtained at initial presentation, just before hospital discharge, and at latest follow-up. ASIA Impairment Scale (AIS)[13] grade was determined for each patient at initial presentation, just before hospital discharge, and at latest follow-up. The ASIA impairment scale, which is based on the American Spinal Injury Association Standard Neurological Classification of Spinal Cord Injury, is graded as: ASIA-A, no sensorimotor function is preserved in the sacral segments S4-S5; ASIA-B, sensory, but not motor function is preserved below the neurological level and includes the sacral segments S4-S5; ASIA-C, motor function is preserved below the neurological level, and more than half of key muscle strength of less than 3; ASIA-D, motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle strength of 3 or more; and ASIA-E, normal sensorimotor function.

All patients received steroids according to National Acute Spinal Cord Injury Study (NASCIS II) guidelines. Specifically, if they presented within the first 8 hours after injury, they received an intravenous bolus of methylprednisolone 30 mg/kg over the first hour and then 5.4 mg/kg/h over the next 23 hours.[14] Blood pressure support was provided if hypotension was observed, using a variety of vasopressor agents to maintain the mean arterial pressure (MAP) at 85 mm Hg.

Details of all patients' surgical procedures were collected from their medical records. All complications were documented from time of injury to latest follow-up. A complication was defined as any undesirable and unexpected event affecting the health of the patient during the follow-up period.[15]

Results

Of the 69 patients included in the study, 39 (57%) were male and 30 (43%) were female. Mean (SD) age was 59 (14.1) years (range, 23-89 years) (Figure 1). Mean follow-up was 11 months (range, 6-60 months). The most common mechanism of injury was a fall (49 patients, 71%), followed by motor vehicle collision (13, 19%), sport injury (6, 8.7%), and traumatic intubation (1, 1.3%) (Figure 2). Mean length of acute care hospitalization after injury was 13 days (range, 2-57 days).

Mean (SD) AMS at presentation was 63.2 (25.8). By

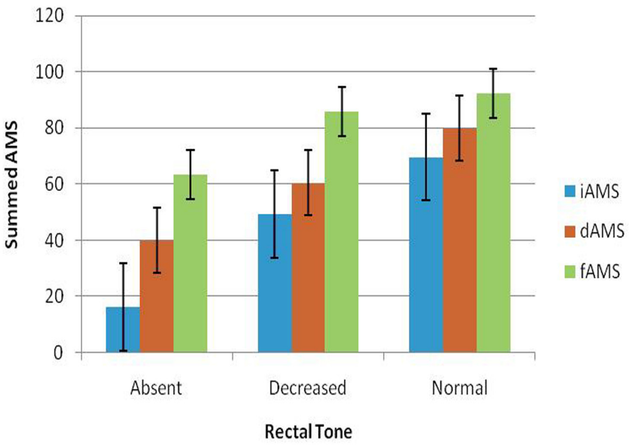

Figure 4. Correlation of rectal tone and American Spinal Injury Association motor score.

hospital discharge, it improved to 72.9 (22.1), and, by the most recent follow-up, it improved further, to 89.9 (14.6) (Figure 3). Improvement in mean AMS between initial presentation and hospital discharge, and between hospital discharge and final follow-up was statistically significant (P = .01 and P<.001, respectively).

Initial AIS grades were ASIA-C (28 patients, 40.6%) and ASIA-D (41, 59.4%). Of the ASIA-C patients, 6 (21.4%) were still ASIA-C at final follow-up, 19 (67.9%) had improved to ASIA-D, and 3 (10.7%) had improved to ASIA-E. Of the ASIA-D patients, 12 (29.3%) were still ASIA-D at final follow-up, and 29 (70.7%) had improved to ASIA-E. Thus, 74% of the patients improved 1 or more AIS grades.

Twenty-nine patients (42%) had a history of loss of consciousness at time of injury. However, there was no significant difference in motor recovery between patients with and without a history of loss of consciousness.

At initial presentation, rectal tone was normal in 53 patients (77%), decreased in 13 patients (19%), and absent in 3 patients (4%). Compared with patients with normal rectal tone, patients with either decreased or absent rectal tone had lower mean summed AMS at initial presentation (P<.001). By final follow-up, however, there was no significant difference in AMS between patients who had abnormal rectal tone initially and those who had normal rectal tone initially. Given the small number of patients lacking rectal tone, it was not possible to break out their results from those of patients with decreased rectal tone (Figure 4).

Thirty-eight patients (55%) had a vertebral column fracture; the other 31 patients (45%) did not have that fracture but showed evidence of degenerative changes with stenosis of the cervical spinal canal. In the patients with a vertebral column fracture, the most common type of injury, using the classification system of Allen and colleagues,[16] was distractive extension (16 patients, 42%), followed by isolated posterior element fracture (13, 35%), compression fracture (4, 10%), burst fracture (2, 5%), teardrop fracture (2, 5%), and facet dislocation (1, 3%). There was no significant difference in initial AMS between patients with a spinal column fracture and patients without that fracture, and at final follow-up there was no significant difference in rate of improvement in AMS between the fracture and no-fracture groups.

Mean time from injury to surgical intervention was 2.9 days (range, 0.25-24 days). Fourteen patients had surgery early (<24 hours after injury), 30 within a midrange period (24-48 hours after injury), and 25 later (>48 hours after injury). Timing of surgery was based on surgeon and patient preference, injury severity, and presence of an evolving neurologic deficit. There was no significant difference in rate of improvement in AMS among the groups treated early, within the midrange, or later.

Surgery was performed using a posterior approach (33 patients, 48%), an anterior approach (22, 31%), or an anteroposterior (AP) approach (14, 21%). All approaches (anterior, posterior, AP) demonstrated statistically significant improvement in AMS between initial presentation and final follow-up, but no significant differences were found among the approaches with respect to motor recovery. All posterior approaches involved a laminectomy; no laminoplasties were included in this series. The approach used was based on location of compression, number of involved levels, and alignment of cervical spine. For patients with focal compression from the intervertebral disks or osteophytes at 1 or 2 levels, an anterior approach was used. Patients with compression of more than 2 levels had posterior laminectomy with fusion. In patients with straight or kyphotic cervical alignment, an AP approach was used.

During follow-up, there were no deaths; 17 patients (24.6%) had a complication. The most common complications were surgical site infection, urinary tract infection, and dysphagia (Table). All surgical site infections occurred in posterior surgical wounds, whereas 2 of the 3 patients who developed dysphagia had undergone an anterior surgical approach.

Discussion

Schneider and colleagues,[5] who described TCCS in 1954, believed that surgical intervention was contraindicated because of the risks inherent in surgery and the overall favorable prognosis for neurologic improvement. Others have also suggested that nonoperative management, rather than surgery, should be used for patients with TCCS because of the risk for neurologic deterioration with surgical intervention.[3,4,17] However, improvements in perioperative management of spinal cord injuries and in techniques of surgical decompression and stabilization have reduced the risks of surgery in this population.[10,18,19] Our study suggests that a favorable amount of neurologic improvement can be expected in patients with surgically managed acute TCCS and that the overall surgical complications are not dramatically

Table. Most Common Complications

Complication	Patients n	Patients %
Surgical Site Infection	4	5.8
Dysphagia	3	4.3
Urinary Tract Infection	3	4.3
Dysphonia	2	2.7
C5 Palsy	1	1.5
New Foot Drop	1	1.5
Deep Vein Thrombosis	1	1.5
Increased Weakness After Surgery	1	1.5
Sepsis	1	1.5

different in scope from those that would be found in a group of age- and comorbidity-matched patients having elective cervical decompression surgery for myelopathy.

Dvorak and colleagues[8] prospectively studied 70 patients with TCCS and reported improvements in motor scores, from a mean (SD) of 58.7 (27.5) at the time of injury to 92.3 (11.6) at the time of follow-up (mean,70 months). More motor improvement was correlated with higher initial AMS, higher level of formal education, and absence of spasticity. Dvorak and colleagues[8] noted motor improvement in most of the patients in their study, with no correlation to presence of a vertebral column fracture. A subset of their patients was treated surgically and had surgical indications similar to those in the present study. Although Dvorak and colleagues[8] found no benefit in AMS improvement for surgically treated patients, they did report significant gains in Functional Independence Measure motor scores.

Timing of surgery for spinal cord injuries remains controversial. Several investigators have reported conflicting results with respect to the benefits of early surgical decompression after an acute cord injury with spinal cord compression.[20-24] Unfortunately, because of its small sample size and lack of prospective assignment to early, midrange, and later surgery groups, our study does not settle the issue as to whether surgical timing is an important factor in managing acute TCCS. Randomized, controlled trials should be considered to determine the role of early surgery in this patient population.

We found that, compared with patients with normal rectal tone, patients with decreased or absent rectal tone had lower summed AMS at time of initial presentation. This is not surprising, as rectal tone is likely a reflection of the degree of motor tract injury within the spinal cord. Guldner and colleagues[25] studied the sensitivity and specificity of rectal tone as an indication of a spinal cord injury in adults after blunt trauma and found that abnormal rectal tone, though an insensitive measure with poor positive predictive value, had 93% specificity and 97% negative predictive value for presence of a spinal cord injury. In our study, the value of abnormal rectal tone as a predictive measure did not show promise because, compared with patients with normal rectal tone at initial presentation, patients with abnormal rectal tone at initial presentation showed no significance at final follow-up. We were not able to break out the group of patients who lacked rectal tone because of the small number of patients with this condition.

Although our overall complication rate, 24.6%, was higher than the 13.4% reported by Boakye and colleagues[26] for elective surgery for cervical spondylotic myelopathy, those investigators did not use a rigorous chart review of all patients during the follow-up period, or did not consider the same broad definition of a complication used in the present study. We used a rigorous definition of a complication: “any undesirable and unexpected” event affecting the health of the patient during the follow-up period. The complications in our study were not intrinsically different from those expected in an elective surgery population, especially given the age and medical status of many of the patients in our study.

Absence of mortality in our study group may suggest a benefit to the early mobilization and rehabilitation feasible after surgical stabilization of a patient with an acute spinal cord injury. By comparison, Harris and colleagues[27] found an overall 3-month mortality rate of 19% in patients 65 years and older after a cervical spine fracture. Risk of mortality at 3 months in the study by Harris and colleagues[27] was, not surprisingly, higher in older patients. In the present study, patients’ mean (SD) age was 59 (14.1) years (range, 23-89 years), and 23 patients (33%) were 65 years and older. Although one could argue that the more healthy patients were selected for surgical intervention and the less healthy patients were treated nonoperatively, our patient cohort’s surgical indications were fracture-related instability and severe cord compression with deteriorating neurologic examination findings and not general medical status per se.

Our study had a few limitations. First, the cohort represented a surgically treated group of patients and there was no nonsurgically treated control group. This was a result of the study design, wherein we decided to specifically examine a surgically treated population of patients with TCCS in order to define the neurologic outcomes and adverse events in this population. Our data cannot be used to define the risks or benefits of surgery, compared with those of nonoperative management in the TCCS population. Second, although AMS are useful in defining motor recovery after traumatic central cord injury, other aspects of neurologic functioning, such as fine coordination and bladder continence, are important in this patient population; we did not include these outcome measures because these data were not available for all the patients in the study. Third, the retrospective nature of this study limits its ability to control for the many variables inherent in the population of patients with spinal cord injuries.

Conclusion

In this study of 69 patients with surgically managed acute TCCS, motor function improved significantly with treatment. History of loss of consciousness, initial abnormal rectal tone, spine fracture, timing of surgery, and surgical approach did not correlate with motor recovery in this study.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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