Clinical/Basic Science Research Article

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Risk factors associated with mortality after traumatic cervical spinal cord injury

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Abstract

Objectives: To investigate the mortality rate following cervical spinal cord injury (SCI) injury and analyze the associated risk factors.

Design: Retrospective cohort study.

Setting: One Level 1 trauma center.

Patients/participants: A cohort of 76 patients with traumatic cervical SCI was reviewed between January 2010 and May 2015, of which 54 patients were selected for the present retrospective study.

Intervention: Operative or conservative treatment.

Main outcome measurements: The following patient parameters were analyzed; age, sex, American Spinal Injury Association (ASIA) impairment scale, neurological impairment level, injury mechanism, radiological findings, treatment, tracheostomy rate, and mortality.

Results: The mean age of the patient cohort was 65 ± 17 years, with 11 females (20%) and 43 males (80%). A total of 16 (30%), 4 (7%), 22 (41%), and 12 patients (22%) were scored A, B, C, and D, respectively, on the ASIA impairment scale. Most of the injuries were at the C4 (30%) and C5 (33%) levels. Falls from standing (35%) and heights (39%) were the most common injury mechanisms. SCI in 40 patients (74%) occurred without major fracture or dislocation. Surgery was performed on 26 patients. The overall mortality was 19%. Patients in the deceased group were significantly older at the time of injury, compared with those who survived. Paralysis had been more severe in the deceased group. A significantly high number of patients in the deceased group received a tracheostomy. When analyzed using a multivariate logistic regression model, an ASIA impairment scale of A was a significant risk factor for mortality.

Conclusions: The risk factors associated with mortality were age, tracheostomy, and an ASIA impairment scale of A, the latter had the highest risk.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Keywords: age, ASIA impairment scale of A, cervical spinal cord injury, mortality, risk factors, tracheostomy

1. Introduction

Spinal cord injury (SCI) often results in severe neurological deficits, which lead to long-term disability. Cervical SCI aggravates respiratory function due to the disruption of innervation to the diaphragm and intercostal muscles, which results in the need for long-term mechanical ventilation. Since mechanical ventilation is associated with increased risk of respiratory complications, early tracheostomy is recommended to reduce complications.[1]

Previous studies have reported that the incidence of traumatic SCI in the elderly population is on the rise.[2–4] The mortality of traumatic SCI in geriatric patients is higher than in young patients.[2,5] In Japan, patients affected by cervical SCI in 2005 were older, in comparison with those in 1990.[4]

The purpose of the present study was to observe the recent trend of traumatic cervical SCI at an advanced critical care and emergency center in Japan, and to investigate the associated mortality rate and patient risk factors.

2. Materials and methods

A total of 76 patients with traumatic cervical spinal injury were treated at our institution between January 2010 and May 2015.

Type of contribution of the authors: TH wrote and prepared the manuscript, and all of the authors participated in the study design. All authors have read and approved the article.

Approval code: B170800013.

The authors have no funding and conflicts of interest to disclose.

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OTA (2018) e003

Received: 29 November 2017 / Accepted: 14 March 2018

http://dx.doi.org/10.1097/OI9.0000000000000003

Among them, the following patients were excluded: 11 patients with cervical spinal injury without neurologic deficits (American Spinal Injury Association [ASIA] impairment scale of E), 5 with severe head injury, 2 with multiple injuries, 1 who had a stroke in the acute stage, 1 who died due to bleeding of gastric ulcer 1 month after injury, and 2 who could not be followed-up. The remaining 54 patients with traumatic cervical SCI were included in the present retrospective study.

The average follow-up period was 19.8 ± 20 months (range: 0.5–72 months). The following data were analyzed: patient age and sex, ASIA impairment scale at admission, level of neurological impairment, injury mechanism, radiological findings, choice of treatment, tracheostomy rate, and mortality. Mortality included in-hospital death and death within one year and over one year of admission. To examine risk factors for mortality in cervical SCI, all patients were categorized into the following 2 groups: deceased patients and patients who survived.

Statistical analysis data were presented as mean ± standard deviation values. A chi-squared test was used to examine differences in outcome measurements between the 2 groups. A *P*-value of $<.05$ was considered statistically significant. A univariate logistic regression model was used to assess risk factors for mortality, and a multivariate logistic regression model was used to analyze significant risk factors. All statistical analyses were performed using IBM SPSS version 24 (IBM Corp., Armonk, NY). This study was approved by our medical ethics board according to the 1964 Helsinki Declaration.

3. Results

Table 1 presents the characteristics of the traumatic cervical SCI patient cohort in the present study. The mean age was 65 ± 17 years, and the cohort included 11 female patients (20%) and 43 male patients (80%). A total of 16 patients (30%) were classified as ASIA Impairment Scale of A, while 4 (7%), 22 (41%), and 12 (22%) patients were classified as an ASIA Scale of B, C, and D, respectively. Although the level of injury was distributed from C3 to T1, most of the injuries occurred at the level of C4 (30%) and C5 (33%). Relatively fewer injuries occurred due to insult at the level of C3 (13%), C6 (11%), C7 (7%), C8 (4%), and T1 (2%). Falls from standing (35%) and heights (39%) were a common cause of injury, followed by traffic accidents (22%). Forty patients (74%) had cervical SCI without major fracture or dislocation. In the whole cohort, 26 patients (48%) had received an operation and 28 patients (52%) had conservative treatment. A tracheostomy was performed on 18 patients (33%). The overall mortality after traumatic cervical SCI was 19%.

The comparison of patients who survived and those who died are summarized in Table 2. At injury, the age of patients who had deceased was significantly greater than those who survived. The ASIA impairment scale was also significantly different between the 2 groups. Paralysis was more severe in the deceased group. The level of neurological impairment, injury mechanism, radiological findings, and treatment did not significantly differ between the 2 groups. Significantly more patients received a tracheostomy in the deceased group than the surviving group.

A univariate logistic regression model (Table 3) indicated that age, an ASIA impairment scale of A, and tracheostomy were significant risk factors for mortality. Since an ASIA impairment scale of A and tracheostomy were close confounding factors in the multivariate logistic regression model, tracheostomy was excluded in the multivariate model. An ASIA impairment scale of A was the most significant risk factor for mortality.

Table 1

Patient characteristics.

	N	%
Sex		
Female	11	20
Male	43	80
ASIA impairment scale		
A	16	30
B	4	7
C	22	41
D	12	22
Level of neurological impairment		
C3	7	13
C4	16	30
C5	18	33
C6	6	11
C7	4	7
C8	2	4
T1	1	2
Injury mechanism		
Fall from standing	19	35
Fall from height	21	39
Traffic accident	12	22
Sports	1	2
Other	1	2
Radiological finding		
Major fracture or dislocation	14	26
No major fracture or dislocation	40	74
Treatment		
Operative	26	48
Conservative	28	52
Tracheostomy		
Yes	18	33
No	36	67
Mortality		
Dead	10	19
Alive	44	81

The patients who had cervical SCI without major fracture or dislocation were divided into the survived group and the deceased group in Table 4. A tracheostomy was more frequently received in the deceased group than in the survived group. 5 of 6 patients (83%) in the deceased group received a tracheostomy. The age and the ASIA impairment scale were not significantly different between the 2 groups.

4. Discussion

Several earlier studies have reported a rise in the incidence of traumatic SCI in geriatric patients.[2–4] Fassett et al[2] reported that the mortality rate of geriatric patients with SCI was much greater, compared to the mortality rate of younger patients with SCI. Pickett et al[5] reported that older age was significantly associated with the risk of death due to traumatic SCI. In the present study, the age of the deceased group was 60 years or over, which, in comparison with the group of patients who survived, was significantly higher and was a risk factor for mortality. The high mortality rate in geriatric patients with SCIs can be attributed to the limited physiological reserve in the geriatric patient.[2] The difference of physical strength between younger patients and elderly patients becomes clear during major trauma, such as a SCI.

Table 2

Comparison between patients who survived or were deceased at the final follow-up.

	Survived N = 44	Deceased N = 10	*P*-value
Age, years	**62.3 ± 18 (20–88)**	**76.7 ± 8.2 (60–88)**	**.001**
ASIA impairment scale			.01
A	9 (20%)	7 (70%)	
B	3 (7%)	1 (10%)	
C	20 (45%)	2 (20%)	
D	12 (27%)	0 (0%)	
Level of neurological impairment			.99
C3	6 (14%)	1 (10%)	
C4	13 (30%)	3 (30%)	
C5	15 (32%)	4 (40%)	
C6	5 (11%)	1 (10%)	
C7	3 (7%)	1 (10%)	
C8	2 (5%)	0 (0%)	
T1	1 (2%)	0 (0%)	
Injury mechanism			.60
Fall from standing	16 (36%)	3 (30%)	
Fall from height	15 (34%)	6 (60%)	
Traffic accident	11 (25%)	1 (10%)	
Sports	1 (2%)	0 (0%)	
Other	1 (2%)	0 (0%)	
Radiological finding			.23
Major fracture or dislocation	10 (23%)	4 (40%)	
No major fracture or dislocation	34 (77%)	6 (60%)	
Treatment			.12
Operative	19 (43%)	7 (70%)	
Conservative	25 (57%)	3 (30%)	
Tracheostomy			.000063
Yes	9 (20%)	9 (90%)	
No	35 (80%)	1 (10%)	

Cervical SCI often causes severe long-time disability due to neurological deficit. Several studies have demonstrated that severe paralysis was associated with mortality.[2,6,7] The present study also demonstrated that an ASIA impairment scale of A was a significant risk factor for mortality in traumatic cervical SCI. Childs et al[8] documented that paralysis of the chest wall and abdominal muscles can lead to respiratory compromise and the need for prolonged mechanical ventilation. Complete paralysis, even in lower cervical SCI, can influence both groups of muscles, causing serious respiratory problems.

The association between the level of neurologic impairment in cervical SCI and mortality is controversial. Shao et al[7] reported that upper level cervical cord injury is a risk factor of early mortality in patients with cervical SCI. Conversely, Childs et al[8] reported that the level of injury did not predict the need for tracheostomy. The results of the present study, which demonstrated that the level of neurological impairment was not significant risk factor of mortality, corroborate with the latter study.

Table 3

Univariate and multivariate logistic regression models for mortality.

	Univariate		Multivariate	
	Odds ratio (95% CI)	*P*-value	Odds ratio (95% CI)	*P*-value
Age	1.1 (1.0–1.2)	.03	1.1 (1.0–1.2)	.06
ASIA impairment scale of A	9.1 (1.9–42)	.005	8.4 (1.6–44)	.01
Neurological level	0.9 (0.6–1.6)	.82	–	
Major fracture or dislocation	2.3 (0.5–9.6)	.27	–	
Operation	3.1 (0.7–13)	.14	–	
Tracheostomy	35 (3.9–313)	.001	–	

CI = confidence interval.

Table 4

Comparison of patients who had cervical SCI without major fracture or dislocation.

	Survived N = 34	Deceased N = 6	*P*-value
Age (years)	**64.1 ± 16 (20–88)**	**77.5 ± 6.3 (69–85)**	**.006**
ASIA impairment scale			.15
A	5 (15%)	3 (50%)	
B	3 (9%)	1 (17%)	
C	17 (50%)	2 (33%)	
D	9 (26%)	0 (0%)	
Level of neurological impairment			.93
C3	2 (6%)	0 (0%)	
C4	10 (29%)	2 (33%)	
C5	13 (38%)	3 (50%)	
C6	3 (9%)	0 (0%)	
C7	3 (9%)	1 (17%)	
C8	2 (6%)	0 (0%)	
T1	1 (3%)	0 (0%)	
Injury mechanism			.20
Fall from standing	14 (41%)	2 (33%)	
Fall from height	11 (32%)	4 (67%)	
Traffic accident	9 (26%)	0 (0%)	
Treatment			.49
Operative	12 (35%)	3 (50%)	
Conservative	22 (65%)	3 (50%)	
Tracheostomy			.0003
Yes	5 (15%)	5 (83%)	
No	29 (85%)	1 (17%)	

Cervical SCI often causes respiratory problems and thus, patients often require long-term mechanical ventilation. The potential for tracheostomy to reduce complications has been previously discussed.[1,8–11] A tracheostomy can reduce the work of breathing, lower the risk of vocal cord injury, and alleviate the need for sedation.[8] However, Shao et al[7] demonstrated that early mortality was significantly higher in patients who underwent tracheostomy, since it breaches the natural barrier between the lung and outside environment, which significantly increases the probability of infection. In the present study, 90% of patients in the deceased group received tracheostomy, compared with 20% of patients in the group that survived. Once the surgical procedure has been performed, closing the tracheostomy in geriatric patients can be very difficult, often causing respiratory complications. Lieberman and Webb[12] reported that the first goal in geriatric patients is to keep the patient mobile to promote respiratory function and maintain mental health. In most cases, geriatric patients who have received a tracheostomy cannot speak or eat anything for very long periods of time. Thus, it can be challenging for geriatric patients with a cervical SCI, who have received a tracheostomy, to maintain their mental health and motivation for rehabilitation. Thus, although many patients with complete paralysis will require a tracheostomy due to severe ventilatory disturbance, an effort should be made to avoid tracheostomy in geriatric patients with incomplete paralysis.

In this study, there are several limitations. One is that this study was a retrospective study that studied a relatively small sample. Secondly, this study was conducted at a single level one trauma center and not at other facilities. This study needs to be reworked as a multicenter study. Lastly, definite criteria for a tracheostomy have yet to be formulated at this institution.

5. Conclusion

The present study reports the mortality of traumatic cervical SCI at an advanced critical care and emergency center in Japan. The risk factors for mortality are age, ASIA impairment scale of A, and tracheostomy. An ASIA impairment scale of A was the risk factor that was most related to mortality in cervical SCI. The older patients with cervical spinal cord injury have a poor prognosis.

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