*Original Article*

# Demographic and Clinical Profiles of Traumatic Spinal Injury Patients at the Siriraj Spinal Unit-Southeast Asia's First Dedicated Spinal Injury Center

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***Background:*** Traumatic spinal injury with or without spinal cord injury (SCI) is a devastating condition that affects the quality and expectancy of life, and that places an economic burden on patients and their family members. Both conditions are associated with greatly reduced independence, and greatly increased disability, morbidity, and mortality. Epidemiological studies in these injuries may facilitate improved preventive measures.

***Objective:*** The aim of the present study was to investigate the demographic and clinical profiles of traumatic spinal injury patients with or without SCI at the Siriraj Spinal Unit - Southeast Asia's first dedicated spinal injury center.

***Materials and Methods*:** This retrospective descriptive analysis included patients who were treated at the Siriraj Spinal Unit of the Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during the 2008 to 2017 study period. The following data were collected and analyzed: age, gender, cause of injury, level and extent of injury, treatment and outcome, length of hospital stay (LOS), and in-hospital mortality.

***Results*:** Six hundred and seventy-one patients were included. The mean age was 45.1 years, and 67.5% were male. Spine injuries were caused by motor vehicle accidents (57.0%), fall from height (31.4%), violent injury (4.6%), and other causes (7%). The cervical spine was the most common site of injury (54.2%). Fifty-one percent of patients had abnormal findings on neurological examination (complete SCI 21.8%, incomplete SCI 25.0%, and nerve root injury 4.2%). Complete SCI was most often observed at the thoracic spine level (61.5%), and the average LOS was longest (96.2 days) in patients with cervical complete SCI. The rate of in-hospital mortality was 0.4% (3/671).

***Conclusion:*** The most common patient profile observed in the present study was middle-aged male, with motor vehicle accident, cervical spine injury, and abnormal neurological exam due to partial SCI. The mortality rate was a very low 0.4%.

***Keywords:*** Epidemiological studies, Trauma, Spinal injuries, Spinal fracture

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Traumatic spinal injury with or without spinal cord injury (SCI) is a devastating condition that affects the quality and expectancy of life, and that places an enormous economic burden on patients and their family members. Patients with SCI are vulnerable to secondary complications that include pressure ulcer, urinary complications, bowel and bladder problems, and sexual dysfunction. SCI is associated with greatly reduced independence, and greatly increased disability, morbidity, and mortality[1]. Epidemiological studies in traumatic spinal injuries may facilitate improved development and implementation of preventive measures to reduce their incidence[2]. Accordingly, the aim of the present study was to investigate the demographic and clinical profiles of traumatic spinal injury patients with or without SCI at the Siriraj Spinal Unit - Southeast Asia's first dedicated spinal injury center.

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## Materials and Methods

This retrospective descriptive analysis included patients who were treated at the Siriraj Spinal Unit of the Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during the January 2008 to December 2017 study period. Siriraj Hospital is Thailand's largest national tertiary referral center. The Siriraj Spinal Unit employs a multidisciplinary approach that includes orthopedic spine surgeons, specially-trained nurses, physical therapists, occupational therapists, counseling psychologists, social workers, and consulting

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physiatrists, internists, and urologists. Spine injury was defined as any spinal fracture and/or dislocation with or without SCI. The following data were collected and analyzed: age, gender, cause of injury, level and extent of injury, treatment and outcome, length of hospital stay (LOS), and in-hospital mortality. The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB) (COA No. 374/2560[EC1]).

### *Statistical analysis*

All data management and analyses were performed using SPSS statistic version 18 (SPSS Inc., Chicago, IL, USA). The variables evaluated in the present study were summarized using descriptive statistics. Data were presented as number, percentage, mean ± standard deviation (SD), or median and range.

## Results

Six hundred and seventy-one patients that sustained traumatic spinal cord injuries with or without SCI during the study period were identified and included.

### *Gender*

The gender proportion breakdown was 67.5% (453/671) males, and 32.5% (218/671) females. The ratio of men to women who sustained spinal injuries was 2.07 to 1 (Table 1).

### *Age*

The average age among all enrolled patients at the time injury was 45.1 years. The average age of patients who suffered from spinal injuries at the cervical spine was 54.8 years, at the thoracic spine was 39.4 years, at the thoracolumbar spine was 46.8 years, and at the lumbar spine was 37 years (Table 1).

### *Cause of injury*

Causes of injury were classified, as follows: motor vehicle accident (MVA), including pedestrian-related injuries and accidents that occurred while patients were traveling in a vehicle; falls, including falls from one's own height, buildings, or trees; violence, including gunshot wounds, stab wounds, and other types of physical aggression; and, others, which includes injuries sustained during sports-related activities and other activities of normal daily living. The leading cause of admission with spinal injury was motor MVA (57.0%), followed by falls (31.4%), violence (4.6%), and others (7.0%) (Table 1). Among the 31 patients that sustained violence-related traumatic spinal injuries, ten suffered from gunshot or stab wounds. Eight of 10 were injured by gunfire (cervical spine: 2, thoracic spine: 5, and thoracolumbar spine: 1), and the remaining 2 patients were stabbed (both in the thoracic spine). Eight of 10 of these patients sustained complete SCI as a result of their injuries.

### *Level of injury*

Regarding the level of injury at admission, the cervical spine was affected in 54.2% of patients (upper cervical spine [C1 to C2] 22.6%, lower cervical spine [C3 to 7] 31.6%), the thoracolumbar spine (T11 to L2) in 31.5% of patients, the thoracic spine (T1 to 10) in 9.7% of patients, and the lumbosacral spine (L3 and below) in 4.6% of patients (Table 1).

**Table 1.** Patient demographic and clinical characteristics (n = 671)

| Demographic data | Mean ± SD, n (%) (n = 671) |
|---|---|
| Age (mean ± SD) | 45.1±17.9 |
| Male gender, n (%) | 453 (67.5) |
| Male/female ratio | 2.07: 1 |
| Level of injury, n (%) | |
| Cervical (C1 to 7) | 364 (54.3) |
| Thoracic (T1 to 10) | 65 (9.7) |
| Thoracolumbar (T11 to L2) | 211 (31.5) |
| Lumbosacral (L3 and below) | 31 (4.6) |
| Cause of injury, n (%) | |
| Motor vehicle accident | 382 (57.0) |
| Fall from height | 211 (31.4) |
| Violence* | 31 (4.6) |
| Others | 47 (7.0) |

* Includes gunshot, stabbing, and other types of aggression

### *Severity of injury*

Of the 671 patients enrolled in this study, 50.9% had abnormal findings on neurological examination. Of those, 21.8% had complete spinal cord injury, 25.0% had incomplete spinal cord injury, and 4.2% had nerve root injury. The other half of enrolled patients had no neurological deficit. The incidence of complete SCI was 19.5% in cervical spine injury, 61.5% in thoracic spine injury, and 19.3% in thoracolumbar spine injury patients. The incidence of incomplete SCI was 34.9% in cervical spine injury, 18.5% in thoracic spine injury, and 13.7% in thoracolumbar spine injury patients (Table 2). More than half of all cervical spine injury (58.1%) and SCI injury (81.8%) occurred at the lower cervical spine (C3 to 7).

### *Management*

Of the 671 included spinal injury patients, 47% were managed conservatively, and the other 53% were managed surgically.

### *Length of hospital stay (LOS)*

The mean length of hospital stay (LOS) by severity of injury was, as follows: complete SCI: 68.6 days, incomplete SCI: 50.7 days, and no SCI: 14.7 days. The longest average LOS was in patients who suffered from complete cervical SCI (96.2 days), followed by incomplete cervical SCI (54.4 days), complete thoracic SCI (47.4 days), and incomplete thoracic SCI (36.9 days).

### *Mortality rate*

The overall mortality rate in this study was 0.4%,

**Table 2.** Level of spinal injury and severity of spinal cord injury (SCI)

| Level of spinal injury | Cervical | Thoracic | Thoracolumbar | Lumbosacral |
|---|---|---|---|---|
| Complete SCI | 71 (19.5%) | 40 (61.5%) | 34 (16.1%) | 1 (3.2%) |
| Incomplete SCI | 127 (34.9%) | 12 (18.5%) | 29 (13.7%) | 0 (0.0%) |
| Nerve root injury | 5 (1.4%) | 2 (3.1%) | 9 (4.3%) | 13 (41.9%) |
| No neurological deficit | 161 (44.2) | 11 (16.9%) | 139 (65.9%) | 17 (54.9%) |
| Total (n = 671) | 364 (54.3%) | 65 (9.7%) | 211 (31.5%) | 31 (4.6%) |

**Table 3.** Type of spinal cord injury (SCI) compared between the upper and lower cervical spine

| Type of spinal cord injury | Complete SCI | Incomplete SCI |
|---|---|---|
| Upper cervical spine (C1 to 2) | 2 (2.8%) | 34 (26.8%) |
| Lower cervical spine (C3 to 7) | 69 (97.2%) | 93 (73.2%) |

or 3 of 671 patients. Two patients sustained incomplete C1 to 2 SCI, and one patient had complete thoracic SCI.

## Discussion

The purpose of this study was to perform a long-term assessment of traumatic spinal injury patients with and without SCI at a tertiary spinal injury center using data from a well-maintained prospective database. The male to female gender ratio observed in the present study of 2.07 to 1 is relatively similar to the ratio reported in our previous study[3], and to the ratio reported by F. Pirouzmand (1.94 to 1)[4]. However, the male to female ratio we observed was different from those reported from other studies, including 5.91 to 1[5], 5.4 to 1[6], 3.59 to 1[7], 3.03 to 1[8], 2.71 to 1[9], 2.55 to 1[10], 2.34 to 1[11,12], and 2.25 to 1[13]. Other studies suggest a global tendency toward a decrease in the male to female patient ratio among traumatic spinal injury patients[2,14-16]. This ratio reduction may be explained by the fact that females are now more likely to spend more time outside of the house working, as opposed to remaining at home in the role of housewife. Although the ratio of males to females is almost always reported to be higher in men than in women[17,18].

### *Age*

The mean admission age of patients in the present study was 45.1 years, which is significantly older than the mean age of 34.4 years that the authors reported in a previous study[3]. However, the mean age the authors reported in this study is relatively similar to those reported in studies from Japan (48.5 years)[10], Taiwan (44 to 46 years)[19], Germany (43.8 years)[20], and Canada (42.2 years)[21], lower than those reported in studies from Portugal (50 years)[22], Eastern Canada (55.4 years)[23], and Japan (53.4 years)[11], and higher than those reported in studies from the USA (37.6 years)[24], Mexico (37.9 years)[7], Italy (38.5 years)[25], and several other studies[2,8,26-29]. The results of several other studies that were conducted in countries across the world suggest an increase in the age at presentation of traumatic SCI[30-35]. This may be due to an increase in the proportion of persons aged greater than 60 years of age. In contrast, Tator et al[36] reported the more recently injured group to be younger, but they had less severe spinal cord injuries.

### *Levels of injury*

In the present study, the level of injury at admission was cervical spine in 54.2% of patients [upper cervical spine (C1 to C2) in 22.6%, and lower cervical spine in (C3 to 7) 31.6%], followed by thoracolumbar spine in 31.5%, thoracic spine in 9.7%, and lumbosacral spine in 4.6%. In our previous study[3], the authors found 50% cervical, 35.3% thoracolumbar, 10.7% thoracic, and 4% lumbosacral spine injury. Other studies found the cervical spine to be most commonly affected (55.5%)[6,9,11], followed by the lumbar spine (28.0%) and the thoracic spine (21.0%)[9].

### *Causes of injury*

The authors found motor vehicle accidents to be the most common cause of traumatic spinal injury (57.7%), followed by falls (31.4%). These findings are comparable to the findings we reported in our previous study (MVA 69.3%, falls 17.3%)[3]. Another study also reported MVA to be the most common injury mechanism (66.0%), followed by falls (15.0%)[37]. MVA was the predominant cause of injury (45.0%), followed by falls (39.6%)[5], and this is similar to several other studies[10,12,14,18,26,36-41]. In contrast, a different study found falls to be the primary cause of traumatic SCI (64.3%)[42], and this rate is similar to other reported rates[6,11,16,17,30,42-47]. Regarding age, we found the mean age at the time of injury to be 45.1 years, which is similar to the mean ages previously described[43,48,49]. The mean age of patients who sustain spinal injuries from traffic accidents, violence, and sport was found to be lower than the mean age of patients that suffer spinal injuries due to falls.

### *Severity of injury*

Of the 342 of 671 patients that had abnormal findings on neurological examination in the present study, 21.8% had complete SCI, 25.0% had incomplete SCI, and 4.2% had nerve root injury. The other 329 patients demonstrated no neurological deficit. Complete SCI occurred at the cervical spine in 19.5% of patients, at the thoracic spine in 61.5%, and at the thoracolumbar spine in 19.3%. The incidence of incomplete SCI was 34.9% in cervical spine

**Table 4.** Mean length of hospital stay (LOS) by location and severity of spinal cord injury (SCI)

| Location | Complete SCI (days) | Incomplete SCI (days) | No neurological deficit (days) |
|---|---|---|---|
| | mean ± SD<br>median (range) | mean ± SD<br>median (range) | mean ± SD<br>median (range) |
| Cervical spine (C1 to 7) | 96.2±113.2<br>69 (1 to 635) | 54.4±123.1<br>34 (1 to 1,253) | 18.4±16.5<br>13 (1 to 116) |
| Thoracic spine (T1 to 10) | 47.4±67.3<br>36.5 (1 to 329) | 36.9±38.1<br>25 (2 to 151) | 15.7±10.9<br>18 (5 to 38) |
| Thoracolumbar spine (T11 to L2) | 36.0±23.6<br>31.5 (3 to 95) | 40.2±38.5<br>29 (4 to 180) | 10.2±12.3<br>8 (1 to 104) |

**Table 5.** Mean length of hospital stay (LOS) by location and type of spinal cord injury and age

| Location and injury type | <60 years | ≥60 years |
|---|---|---|
| | mean ± SD, median (range) | mean ± SD, median (range) |
| Cervical 3 to 7 complete | 80.6±93.7<br>66 (1 to 579) | 123.5±152.7<br>69 (6 to 635) |
| Cervical 3 to 7 incomplete | 51.6±135.2<br>34 (1 to 1,253) | 39.8±96.7<br>33 (5 to 658) |
| Thoracic (T1 to 10) complete | 47.9±70.4<br>36 (1 to 329) | 43.0±24.2<br>43.5 (21 to 64) |
| Thoracic (T1 to 10) incomplete | 47.0±47.0<br>26 (17 to 151) | 22.8±15.6<br>18 (2 to 39) |
| Thoracolumbar (T11 to L2) complete | 37.6±23.9<br>32.5 (3 to 95) | 19.7±8.1<br>16 (10 to 27) |
| Thoracolumbar (T11 to L2) incomplete | 44.7±42.0<br>25 (6 to 180) | 28.5±29.5<br>31.5 (4 to 85) |

injury, 18.5% in thoracic spine injury, and 13.7% in thoracolumbar spine injury patients. A previous study reported the thoracolumbar junction to be the most common site of injury, followed by the lower cervical spine[18]. Previous study reported a rate of cervical SCI with complete cord injury of 22.0%[50], while another study reported that 43.0% patients had complete spinal cord injury, 33.0% had incomplete SCI, and 24.0% did not have SCI[35]. More than half of all cervical spine fractures (58.1%), and 81.8% of cervical SCIs occurred at the lower cervical spine (C3 to 7). Among cervical spine SCIs in the present study, the authors found that 34.9% had incomplete SCI, and 19.5% had complete SCI, which is similar to the rates reported in other studies[44,48,49,51]. This may be explained by the introduction and enforcement of traffic laws to decrease severity of injury (e.g., speed limits, seat belts, and helmets), and improvements in the quality of care given to traumatically injured patients.

### *Management*

Of the 671 spinal injury patients included in the present study, 47.0% were managed conservatively, and 53.0% were managed surgically. Agarwal P[29] reported that 74.4% of patients were managed conservatively, and the remaining 25.6% of patients were managed surgically. Roohi SA[18] managed less than 10% of their patients surgically. In contrast, Qureshi MA[35] managed 70% of their patients surgically.

### *Length of hospital stay (LOS)*

The mean LOS in patients with complete SCI was 68.6 days, incomplete SCI 50.7 days, and no SCI 14.7 days. Mean LOS was longest in patients who suffered from complete cervical SCI (96.2 days), followed by incomplete cervical SCI (54.4 days), complete thoracic SCI (47.4 days), and incomplete thoracic SCI (36.9 days). In our previous study, we found and reported a mean LOS of 62.3 days for complete SCI, and of 40.9 days for incomplete SCI[3]. Longer LOS was observed in patients with more severe injury. When LOS was compared between age groups (<60 years vs. ≥60 years), only lower cervical spine complete SCI patients had longer LOS. This may be explained by greater severity of injury in younger age group than in older age group. A study from Nepal reported a mean LOS of 31 days[17]. A Canadian study reported an average LOS in spinal injuries of 18 days, in SCIs of 27 days, and in cervical SCIs of 29 days[40]. That same Canadian study also reported LOS to be reduced about 50% in both the spinal injury and SCI groups[40], and that age and SCIs were found to be associated with longer LOS[40]. The LOS days in the present study are longer than those

previously reported due to the fact that our institutional policy is to treat spinal injury patients from the acute phase through to completion of the rehabilitation phase.

### *Mortality rate*

The 0.4% mortality rate observed in the present study is similar to the 0.5% rate reported by Williams BJ[52], and less than the rates reported by Kattail D (4%)[13], Passias PG (6.6%)[53], and Small TJ (8.9%)[54]. Pirouzmand F[4] reported an average case fatality rate of 16.7% for the entire study period, a 16.7% rate among all trauma patients with spinal injuries, and a 21.0% rate among patients with chronic spinal cord injuries (CSCIs). The observed decline in short-term mortality may be explained by improvements in the care given to patients with spinal injuries, including increased and improved hospital resources with more centralized care, and referral of cases from other hospitals[55-57] Struss, et al reported improvements in model SCI systems and improvements in hospital SCI units to be factors that influence a decrease in the mortality rate among spinal injury patients[57]. Increased age, male gender, injury severity score (ISS), and blood pressure at presentation were reported to be significant predictors of mortality[58].

### *Limitations*

The notable limitation of the present study is its retrospective design, which renders it vulnerable to incomplete or missing data. That acknowledged limitation is outweighed by the lengthy ten-year study period, and the accuracy of the data, which was collected from the database of an established dedicated spinal injury care center.

## Conclusion

The most common patient profile observed during the study period was middle-aged male that was injured in a motor vehicle accident, that sustained injury to the cervical spine, and that had abnormal neurological exam due to partial SCI. The mortality rate in this study was a very low 0.4% (3/671 patients).

## What is already known on this topic?

Traumatic spinal injury with or without spinal cord injury (SCI) is an injury that can be sustained from a variety of different causes, including motor vehicle accident, fall, violence, and other causes that include sports-related activities and other activities of daily living. Epidemiological studies in these injuries may facilitate improved preventive measures.

## What this study adds?

This 10-year retrospective study revealed 671 cases of traumatic spinal injury with or without SCI at the Siriraj Spinal Unit during 2008 to 2017. The most common patient profile observed in this study was middle-aged male, with motor vehicle accident, cervical spine injury, and abnormal neurological exam due to partial SCI. The mortality rate was a very low 0.4%.


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## Potential conflicts of interest

The authors declare no conflicts of interest.

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