Indian J Med Res 140, July 2014, pp 40-45

Mortality profile of patients with traumatic spinal injuries at a level I trauma care centre in India

S. Lalwani, V. Singh*, V. Trikha*, V. Sharma*, S. Kumar, R. Bagla, D. Aggarwal** & M.C. Misra†

*Departments of Forensic Medicine And Toxicology, *Orthopaedics, **Neurosurgery & †Surgical Disciplines, Jai Prakash Narayan Apex Trauma Center, All India Institute of Medical Sciences, New Delhi, India*

Received September 20, 2012

***Background & objectives*: There is no national spinal trauma registry available in India at present and the research on epidemiology of these injuries is also very limited. The purpose of this study was to describe the mortality profile of patients with spinal injuries brought to a level I trauma centre in India, and to understand the predictive factors which identify patients at an increased risk of spinal trauma mortality.**

***Methods*: Retrospective data were collected from computerized patients records and autopsy reports maintained in the department of Forensic Medicine. All the cases with spinal injuries whether in isolation or as a part of polytrauma were reviewed. A total of 341 such cases were identified between January 2008 to December 2011. The demographic data, type of trauma, duration of survival, body areas involved, level of spinal injury and associated injuries if any, were recorded.**

***Results*: There were 288 (84.45%) males and 53 (15.55%) females. Most victims (73%) were between 25 and 64 yr of age, followed by young adults between 16 and 24 yr (19.35%). Male: female ratio was 5.4:1. Fifty five per cent cases had spinal injuries in isolation. Injury to the cervical spine occurred in 259 (75.95%) patients, thoracic spine in 56 (16.42%) and thoraco-lumbar spine in 26 (7.62%) patients. The commonest cause of injury was high energy falls (44.28%), followed by road traffic accidents (41.93%). The majority of deaths (51.6%) occurred in the phase IV (secondary to tertiary complications of trauma, *i.e.* >1 wk). Forty patients died in phase I (brought dead or surviving <3 h), 55 in phase II (>3 to 24 h) and 70 in phase III (> 24 h to 7 days).**

***Interpretation & conclusions*: Our data suggest that there is an urgent need to take steps to prevent major injuries, strengthen the pre-hospital care, transportation network, treatment in specialized trauma care units and to improve injury surveillance and the quality of data collected which can guide prevention efforts to avoid loss of young active lives.**

Key words Injury prevention - mortality patterns - post-traumatic - spinal injuries

Accurate mortality statistics are important for implementing appropriate prevention strategies, improving emergency preparedness, instituting financing policies and appropriate health packages. These data must come from census, mortality reports, hospital databases, community-based reports and other such sources. India is experiencing an increasing trend in injuries, particularly due to road traffic accidents at an alarming annual rate of 3 per cent[1]. The World Report on Road Traffic Injury Prevention indicates that by 2020, road traffic injuries will be a major killer accounting for half a million deaths and 15 million disability adjusted life years (DALYs) lost[2]. Evidence supports the fact that timely referral to trauma centres, equipped with proper facilities to deal with serious injuries, results in reduction of mortality among victims[3].

There is an urgent need for concerted efforts for effective and sustainable prevention and management of injuries in India. One of the essential needs is to establish the trauma registries to monitor the system and provide State-wide cost and epidemiological statistics. The information systems regarding trauma, in most places, are manual records and hence grossly inadequate.

No national spinal cord injury (SCI) registry available in India to describe the mortality characteristics of the traumatic spinal cord injury (SCI). Furthermore, there is no accurate assessment of the number of individuals who suffer from SCI in India every year. Hence, the research on epidemiology of traumatic SCI in India is very limited[4,5].

The purpose of this study was to describe the mortality profile of patients with spinal injuries in isolation or as a component of polytrauma. The study was aimed to identify pattern of deaths according to: *(i)* mechanism of injury; *(ii)* age; *(iii)* cause of death; *(iv)* associated injuries; and *(v)* time of death. The intention was to understand the predictive factors that identify patients at an increased risk of spinal trauma mortality.

Material & Methods

This study was conducted at a level I trauma centre in New Delhi, India. This centre (Jai Prakash Narayan Apex Trauma Centre, All India Institute of Medical Sciences, New Delhi, India) admits about 3500 patients every year, and has no assigned trauma catchment area or geographic jurisdiction.

Retrospective data were collected from CPRS (computerized patient record system) of this hospital and autopsy reports maintained in the department of Forensic Medicine. All the cases/autopsy reports with spinal injuries whether in isolation or as a part of polytrauma were reviewed. For the purpose of the study, the trauma was defined as an injury to living tissue caused by an extrinsic agent, examples included the consequences of motor vehicle accidents, falls, gunshots, physical assaults or other forms of trauma. A total of 341 such cases were identified between January 2008 to December 2011. The demographic data, type of trauma, duration of survival, body areas involved, level of spinal injury and associated injuries if any, were recorded. Also, information like mode of shifting of patient from site of accident, education of attendants, duration of shifting from site of injury to the center, treatment taken in other setups, whether helmet worn or not, *etc*. was also recorded. Level of injury was defined as cervical spine injury (CSI) when it included C1–C7; thoracic spine injury (TSI) when it was T1–T10 and thoraco-lumbar injury (TLI) when it was T11– L5.

Based on survival period, the duration of survival was divided into four phases[6]: Phase-I from the scene of incidence to arrival of the patients to hospital (Pre-hospital – spot or brought dead), Phase-II from initial assessment in the casualty/emergency department to shifting to ICU/operation theatre (>3 to 24 h), Phase-III from surgical intervention/ICU to secondary complication (>24 h to 1 wk) and Phase-IV from secondary to tertiary complication of trauma (>1 wk). The data were compiled, analysed and the results presented (Table I).

The study protocol was approved by the institutional ethics committee.

Results

Spinal injuries were observed in 341 autopsy cases/records in the study period. There were 288 (84.45%) males and 53 (15.55%) females. Most victims (73%) were between 25 and 64 yr of age, followed by young adults between 16 and 24 yr (19.35%) (Table I). Only 5 per cent cases were above 65 yr of age. The male: female ratio was 5.4:1.

A total of 189 (55.43%) cases had spinal injuries in isolation. Injury to the cervical spine occurred in 259 (75.95%) patients, while 56 (16.42%) patients had thoracic spine injury and in another 26 (7.62%) thoraco-lumbar spine was involved. The commonest cause of spinal cord injury was high energy falls (151 patients;

Table I. Demographic distribution of fatalities in patients (n=341)

Variable	No. Number (%)
Gender	
Male	288 (84.45)
Female	53 (15.55)
Age group (yr)	
< 15	9 (2.63)
16-24	66 (19.35)
25-34	92 (26.98)
35-44	70 (20.53)
45-54	61 (17.89)
55-64	26 (7.62)
>65	17 (4.98)
Associated injuries	
Head	58 (17)
Chest	17 (4.98)
Abdomen	6 (1.76)
Head & chest	12 (3.52)
Head & abdomen	11 (3.22)
Head, chest & abdomen	15 (4.40)
Chest & abdomen	15 (4.40)
Long bone fracture	18 (5.28)
No associated injury	189 (55.42)
Region involved	
Cervical spine	259 (75.95)
Thoracic spine	56 (16.42)
Thoraco-lumbar spine	26 (7.62)
Time of death	
Phase I	40 (11.73)
Phase II	55 (16.13)
Phase III	70 (20.53)
Phase IV	176 (51.61)

44.28%), closely followed by road traffic accidents (143 patients; 41.93%). Any fall from a height of more than 20 feet in adults and 10 feet in children was considered high energy fall[7]. The other causes were fall of heavy object (17 cases; 4.9%), railway track accidents (9 cases; 2.6%), assault (10 cases; 2.93%), and other miscellaneous causes (11 cases; 3.22%). Interestingly, the leading mechanism of injury in 25-60 yr age group was found to be high energy falls (122 cases; 49%), while it was road traffic accidents (34 cases; 51.5%) in the age group of 16-24 yr.

In 152 (44.57%) cases spinal injuries were seen in combination with injuries on other body regions. Fifty eight (38%) cases had associated head injury while 17 (11%) cases were having associated chest trauma. A combination of associated head and chest injury in 12 (8%), head and abdominal injury in 11 (7%), head, chest and abdominal injury in 15 (10%) and chest and abdominal injury in another 15 (10%) was found (Table I).

The majority of deaths (176 cases; 51.61%) occurred in the phase IV due to tertiary complications of trauma (>1 wk). Forty (11.73%) patients died in phase I while 55 (16.13%) died in phase II (>3 to 24 h). Trauma victims dying in phase I were either those who died at the scene of incidence or on the way before reaching to the hospital. A total of 95 patients survived less than 24 hours. Seventy (20.53%) patients died in phase III (> 24 h to 7 days). Of the 95 cases who survived less than 24 h, 82 (86.3%) had some associated injury while it was present in only 70 (28.5%) of the 246 cases who survived more than 24 h. The common causes of death in phases I and II were found to be head injury, haemodynamic instability and neurogenic shock while in phases III and IV the common causes were sepsis secondary to multiple organ failure and complications of chronic respiratory insufficiency (Table II).

Discussion

Only a few studies have been published from India on trauma related mortality[8,9] and none on mortality profile of patients with spinal injuries. This study is the first of its kind in India describing the profile of early deaths in 341 post traumatic spinal injury patients. Males (84.45%) were found to be more prone to spinal cord injury in our study, as reported from other countries also, as they are usually engaged in outdoor work and hence are more prone to spinal cord injury and/or other trauma[10-14]. In our study male: female ratio was 5.4:1. Male predominance has been reported from India and other developing countries[14-17].

Our study also reflected the age group of 25-64 yr being the most susceptible for spinal injuries. In other studies the mean age of patients with SCI reported varied from 30.9 - 38.9 yr[13,18,19].

Falls as the leading cause of SCI have been reported from developing countries like Bangladesh, Turkey,

Table II. Distribution of deaths

No.of deaths	Duration of survival	Cases having isolated spinal injury	Cases having spinal injury associated with other injuries	Cause of death
Phase I 40 (11.73%)	Brought dead/<3 h	4	36	• Head injury-19 • Haemodynamic instability-17 • Neurogenic shock-4
Phase II 55(16.13%)	>3 -24 h	5	50	• Head injury-35 • Haemodynamic instability-20
Phase III 70(20.53%)	>24 h-7 days	20	50	Sepsis
Phase IV 176(51.61%)	>7 days	160	16	Sepsis

Pakistan and Nigeria[13,16,20-22]. Most of the houses in rural and urban areas lack essential safety precautions like fencing of the terrace and guarding of the staircase, thereby making fall from height a realistic possibility. Wells in rural India lack essential safety precautions thus putting the people working in close range at risk[5]. Road traffic accidents were the second commonest aetiology in our study with 41.93 per cent deaths. In a recent large series from India, road traffic accidents were found to be the leading cause of SCI closely followed by falls[4].

In our study the associated injuries to the head were most common followed by injuries to the thorax, abdomen and extremities. Similar results have been reported in other studies[3,23,24].

Only 27.86 per cent of all the cases survived for less than 24 h post-trauma and of these, majority (86.3%) had some associated injuries. Hence, most of the early deaths (almost one fourth of all) were in patients who sustained polytrauma along with spinal injury. A study from Puducherry[25] demonstrated that mean delay caused from the time of accident to the time at admission was 14.9 hours and 37 per cent had at least two changes of vehicle before admission, adding to the delay. This is in keeping with the experience in other developing countries where a 6-hour delay contributed to poor outcome[26].

It was also observed that attendants accompanying patients having cervical spine injury had little knowledge regarding precautions to be taken to prevent further neurological deterioration during transportation. The place of first medical encounter is decided more often by the relatives, bystanders, and police. In this chaos, the patient is taken to the closest medical facility, which may be grossly inadequate to deal with serious trauma. The golden hour is thus spent without appropriate resuscitation. Expeditious and careful transport of patients with acute cervical spine or spinal cord injuries should be carried out from the site of injury by the most appropriate mode of transportation available to the nearest capable definitive care medical facility. In India, proper coordination between the trauma receiving facility and ambulance services is present in as low as 4 per cent of the pre-hospital network[1]. It has been shown that minimizing pre-hospital time greatly helps in reducing trauma mortality and morbidity[27]. Chandra *et al*[24] observed that the spot deaths had markedly declined by introducing the special mobile ambulance services to accident patients.

In our study 20.5 per cent of the trauma patients died in phase III (>24 h to 7 days) due to respiratory failure or as a result of post-traumatic complications. A substantial proportion of patients (51.61%) who survived for more than one week (phase IV), later died as a result of secondary complications like sepsis or multiple organ system failure. Similar observation have been reported by Reber *et al*[28]. It has been shown that respiratory insufficiency and related complications are the most common causes of morbidity and mortality in acute SCI with an incidence of 36 to 83 per cent[29]. It is also noteworthy that ventilatory failure may last up to an average of five weeks causing delayed deaths in these cases[30]. Efforts to improve respiratory function and minimize respiratory complications reduce mortality[29,31,32].

Sepsis may result from focus in the bladder due to catheterization, respiratory tract from aspiration, hypostatic pneumonia from respiratory insufficiency, the skin from bed sores and intravenous lines. Adequate attention and preventive measures like intermittent catheterization, aseptic procedures in setting up intravenous line, chest physiotherapy and pulmonary toileting and frequent turning of patients to prevent bed sores help to reduce mortality from sepsis[33].

There is a need to set up more specialized spinal trauma units across the country with good accessibility to poorer sections of society for comprehensive management of spinal cord injured patients. Early liaison of hospitals without specialized spinal units to specialized spinal centres should be encouraged, so that early presentation of acute spinal cord injured patient to a specialized spinal unit leading to early total care and reduction of mortality can be carried out[10].

There is a need to increase tertiary trauma care units with multidisciplinary approach for comprehensive care of critically injured patients. Steps must also be taken to improve injury surveillance and the quality of data collected. Detailed, complete and relevant data will guide prevention efforts aimed at risk factors in the individual and the environment and provide feedback to trauma care providers. Further monitoring of these trends will influence training, improve the focus of the trauma service and direct the provision of more effective care to these severely injured patients. These findings also suggest the need to allocate resources for trauma prevention, and promote research towards improving the care of acutely injured patients.

References

1. Joshipura MK, Shah HS, Patel PR, Divatia PA, Desai PM. Trauma care systems in India. *Injury* 2003; *34* : 686-92.
2. World Health Organization. Strategic plan for injury prevention and control in South-East Asia, April 2002. Available from: *http:apps.searo.who.int/pds_docs/B1470.pdf*, accessed on July 14, 2014.
3. Mock CN, Jurkovich GJ, nii-Amon-Kotei D, Arreola-Risa C, Maier RV. Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development. *J Trauma* 1998; *44* : 804-12.
4. Chhabra HS, Arora M. Demographic profile of traumatic spinal cord injuries admitted at Indian Spinal Injuries Centre with special emphasis on mode of injury: a retrospective study. *Spinal Cord* 2012; *50* : 745-54.
5. Pandey VK, Nigam V, Goyal TD, Chhabra H. Care of post-traumatic spinal cord injury patients in India: an analysis. *Indian J Orthop* 2007; *41* : 295-9.
6. Singh B, Palimar V, Arun M, Mohanty MK. Profile of trauma related mortality at Manipal. *Kathmandu Univ Med J* 2008; *6* : 393-8.
7. Guidelines for trauma definition. Available from : *http://www.bac-ems.com/downloads/TraumaTriageTransportDef&Guideline10-04.htm*, accessed on July 14, 2014.
8. Kalaiselvana G, Dongre AR, Mahalakshmy T. Epidemiology of injury in rural Pondicherry, India. *J Inj Violen Res* 2011; *3* : 62-7.
9. Jha N, Srinivasa DK, Roy G, Jagdish S. Injury pattern among road traffic accident cases: a study from South India. *Indian J Community Med* 2003; *28* : 85-90.
10. Amin A, Bernard J, Nadarajah R, Davies N, Gow F, Tucker S. Spinal injuries admitted to a specialist centre over a 5- year period: a study to evaluate delayed admission. *Spinal Cord* 2005; *43* : 434-7.
11. Nwadinigwe CU, Iloabuchi TC, Nwabude IA. Traumatic spinal cord injuries (SCI): a study of 104 cases. *Niger J Med* 2004; *13* : 161-5.
12. O'Connor RJ, Murray PC. Review of spinal cord injuries in Ireland. *Spinal Cord* 2006; *44* : 445-8.
13. Solagberu BA. Spinal cord injuries in Ilorin, Nigeria. *West Afr J Med* 2002; *21* : 230-2.
14. Surkin J, Gilbert J, Harkey HL 3rd, Sniezek J, Currier M. Spinal cord injury in Mississippi. Findings and evaluation, 1992-1994. *Spine* 2000; *25* : 716-21.
15. Chacko V, Joseph B, Mohanty SP, Jacob T. Management of spinal cord injury in a general hospital in rural India. *Paraplegia* 1986; *24* : 330-5.
16. Hoque MF, Grangeon C, Reed K. Spinal cord lesions in Bangladesh: an epidemiological study 1994-1995. *Spinal Cord* 1999; *37* : 858-61.
17. Raja IA, Vohra AH, Ahmed M. Neurotrauma in Pakistan. *World J Surg* 2001; *25* : 1230-7.
18. Kishan S, Vives MJ, Reiter MF. Timing of surgery following spinal cord injury. *J Spinal Cord Med* 2005; *28* : 11-9.
19. [No authors listed]. Transportation of patients with acute traumatic cervical spine injuries. *Neurosurgery* 2002; *50* (Suppl 3) : S18-20.
20. Karamehmetoglu SS, Unal S, Karacan I, Yilmaz H, Togay HS, Ertekin M, *et al*. Traumatic spinal cord injuries in Istanbul, Turkey. An epidemiological study. *Paraplegia* 1995; *33* : 469-71.
21. Rathore MF, Hanif S, Farooq F, Ahmad N, Mansoor SN. Traumatic spinal cord injuries at a tertiary care rehabilitation institute in Pakistan. *J Pak Med Assoc* 2008; *58* : 53-7.
22. Odeku EL, Richard DR. Peculiarities of spinal trauma in Nigeria. *West Afr Med J Niger Pract* 1971; *20* : 211-25.
23. Menon A, Pai VK, Rajeev A. Pattern of fatal head injuries due to vehicular accidents in Mangalore. *J Forensic Leg Med* 2008; *15* : 75-7.
24. Chandra J, Dogra TD, Dikshit PC. Pattern of cranio-intracranial injuries in fatal vehicular accidents in Delhi, 1966-76. *Med Sci Law* 1979; *19* : 186-94.
25. Radjou AN, Balliga DK, Pal R, Mahajan P. Injury-related mortality audit in a regional trauma center at Puducherry, India. *J Emerg Trauma Shock* 2012; *5* : 42-8.

26. Cheddie S, Muckart DJ, Hardcastle TC, Den Hollander D, Cassimjee H, Moodley S. Direct admission versus inter-hospital transfer to a level I trauma unit improves survival: an audit of the new Inkosi Albert Luthuli Central Hospital Trauma Unit. *S Afr Med J* 2011; *101* : 176-8.
27. Mock C. Strengthening prehospital trauma care in the absence of formal emergency medical services. *World J Surg* 2009; *33* : 2510-1.
28. Reber PU, Schmied B, Seiler CA, Baer HU, Patel AG, Bachler MW. Missed diaphragmatic injuries and their long term sequelae. *J Trauma* 1998; *44* : 183-8.
29. Chen S, Lin CM, Lee CW, Huang CY, Chiang LL. The experience in respiratory care of a patient with cervical spinal cord injury. *FJPT* 2008; *33* : 294-301.
30. Berlly M, Shem K. Respiratory management during the first five days after spinal cord injury. *J Spinal Cord Med* 2007; *30* : 309-18.
31. Claxton AR, Wong DT, Chung F, Fehlings MG. Predictors of hospital mortality and mechanical ventilation in patients with cervical spinal cord injury. *Can J Anaesth* 1998; *45* : 144-9.
32. Martin MJ, Weng J, Demetriades D, Salim A. Patterns of injury and functional outcome after hanging: analysis of the National Trauma Data Bank. *Am J Surg* 2005; *190* : 836-40.
33. Kawu AA, Alimi FM, Gbadegesin AA, Salami AO, Olawepo A, Adebule TG, *et al*. Complications and causes of death in spinal cord injury patients in Nigeria. *West Afr J Med* 2011; *30* : 301-4.

Reprint requests: Dr Vivek Trikha, Associate Professor, Department of Orthopaedics, Jai Prakash Narayan Apex Trauma Center, All India Institute of Medical Sciences, New Delhi 110 029, India
e-mail: vivektrikha@gmail.com