Published online: 2019-07-23

Outcome Analysis of Upper versus Lower Cervical Spine Injuries

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Indian J Neurotrauma 2018;15:100–105

Abstract

Back Ground/Objective Cervical spine injuries are considered to be a major trauma and classified in various types. They are associated with various neurologic deficits and mortality rates. They account for 50 to 75% of all spine injuries. Various studies are associated with outcome of spinal cord injuries. Our aim was to analyze outcome of upper and lower cervical spine injuries.

Study Design It was a retrospective study in all traumatic cervical spine injuries in all age groups at our center during the past 3 years.

Method All cases operated in the past 3 years at our center were taken up for study. Initial hospital records were reviewed. Patients will be divided into two groups on the basis of anatomic level upper (C1 and C2) and lower (C3 or below) cervical spine. Outcomes were analyzed on criteria of demography, mechanism of injury, preoperative neurologic status, involvement of respiratory system, and time of surgery following injury.

Result tatically significant test was applied for analysis of outcome of cervical spine injury based on aforementioned criteria.

Conclusion In this study, survival rates of patients with upper and lower cervical spine injuries were calculated on the basis of mechanism of injury, preoperative neurologic status, respiratory involvement, and time of surgery following injury. Operative treatment of lower cervical injury was better associated with an improved outcome than upper cervical spine injuries. Further prospective study is required for better assessment.

Keywords
- cervical spinal cord
- injury
- outcome analysis

Introduction

Spinal cord injury (SCI) is one of the common causes of severe disability and death. Cervical spine injuries are considered to be a major trauma and characterized by a diversity, high risk of severe neurologic complication, and mortality rate.[1-4] Injury to the cervical spinal cord accounts for 2 to 3% of trauma patients and 8.2% of all trauma-related deaths.[5] It includes 50 to 75% of all spine injuries.[1-6] Suspicion, early diagnosis of injury, preservation of spinal cord function, maintenance or restoration of spinal alignment, and stability are keys to successful management. Approximately 12,000 new cases (40 cases/million) are added every year to the existing 0.3 to 0.5 million victims in the United States. The situation is worse in developing countries such as India where the prevalence ranges from 236 to 750 per million.

The incidence of SCI is on a rise, and the impact on the health care system and economy is tremendous. Advances in emergency medical care or ambulance services have positively affected outcomes in trauma; however, the situation for SCI still remains a cause of concern. There has been a major shift from conservative management for these injuries to decompression of cord, stabilization of the spine, early mobilization, and rehabilitation. However,

published online
July 23, 2019

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DOI https://doi.org/10.1055/s-0038-1676906
ISSN 0973-0508.

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prevention of secondary insult to the cord in the "golden hour" is paramount. Although there have been advances in achieving spinal stabilization and decompressions of the cord, functional outcomes are a matter of concern. Several factors influence the neurologic outcome following cervical SCI. There are well-established criteria regarding the choice of treatment technique.[7]

Material and Methods

Study Setting

A complete database review was performed for all traumatic cervical spine injuries treated at Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, over a period of 3 years from 2014 to 2017. Total 36 patients were identified and their records, radiographic studies, daily progress notes, and procedure records, and discharge summary reports were taken to ensure completeness. The following information was collected for each patient: age, sex, injury mechanism, neurologic deficit, anatomical level of injury, and respiratory involvement. On the basis of aforementioned criteria, results were analyzed for two groups: upper and lower cervical spine, and all calculations for statistical significance were done (►**Figs. 1**, **2**).

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients with spinal injuries from C1 to C7 level.
- Patients who were managed surgically.

Exclusion Criteria

- Patients having other associated injuries, for example head injuries, penetrating injuries.
- Patients managed conservatively.
- Patients with severe autonomic disturbances such as systolic blood pressure < 90 mm Hg and heart rate < 40 beats/min.

Patient Characteristics

S. no.	Parameter	Frequency (*n*)
1	Age group (y)	10 (21.3)
	< 35	15
	≥ 35	21
2	Sex	
	Male	33
	Female	3
3	Mechanism of injury	
	RTA	13
	Fall	23
4	Duration of injury (wk)	
	< 1	26
	> 1	10
5	Neurologic deficit	
	Present	33
	Absent	3
6	Respiratory involvement	
	Present	13
	Absent	23
7	Level of injury	
	Upper	6
	Lower	30

Statistical Analysis

Characteristics of each group compared by using chi-square test method. Statements of statistical significance were made at $\alpha < 0.05$ level. The Yate's modification was applied where frequencies were < 5.

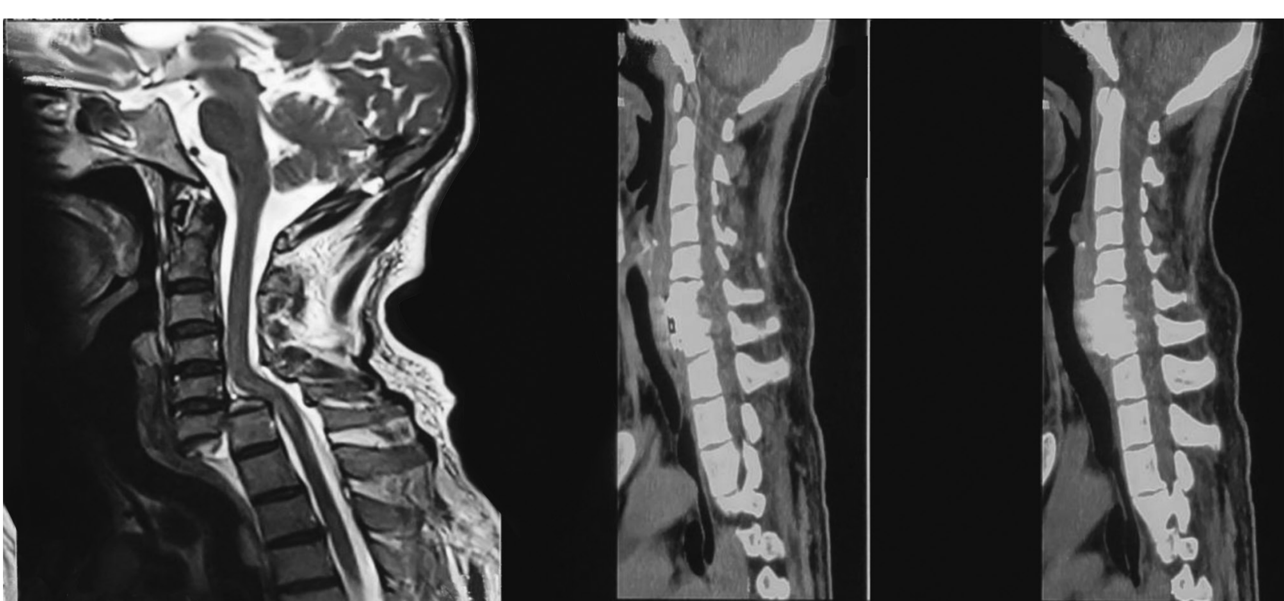

Fig. 1 Images of lower cervical spine injury operated by anterior cervical approach.

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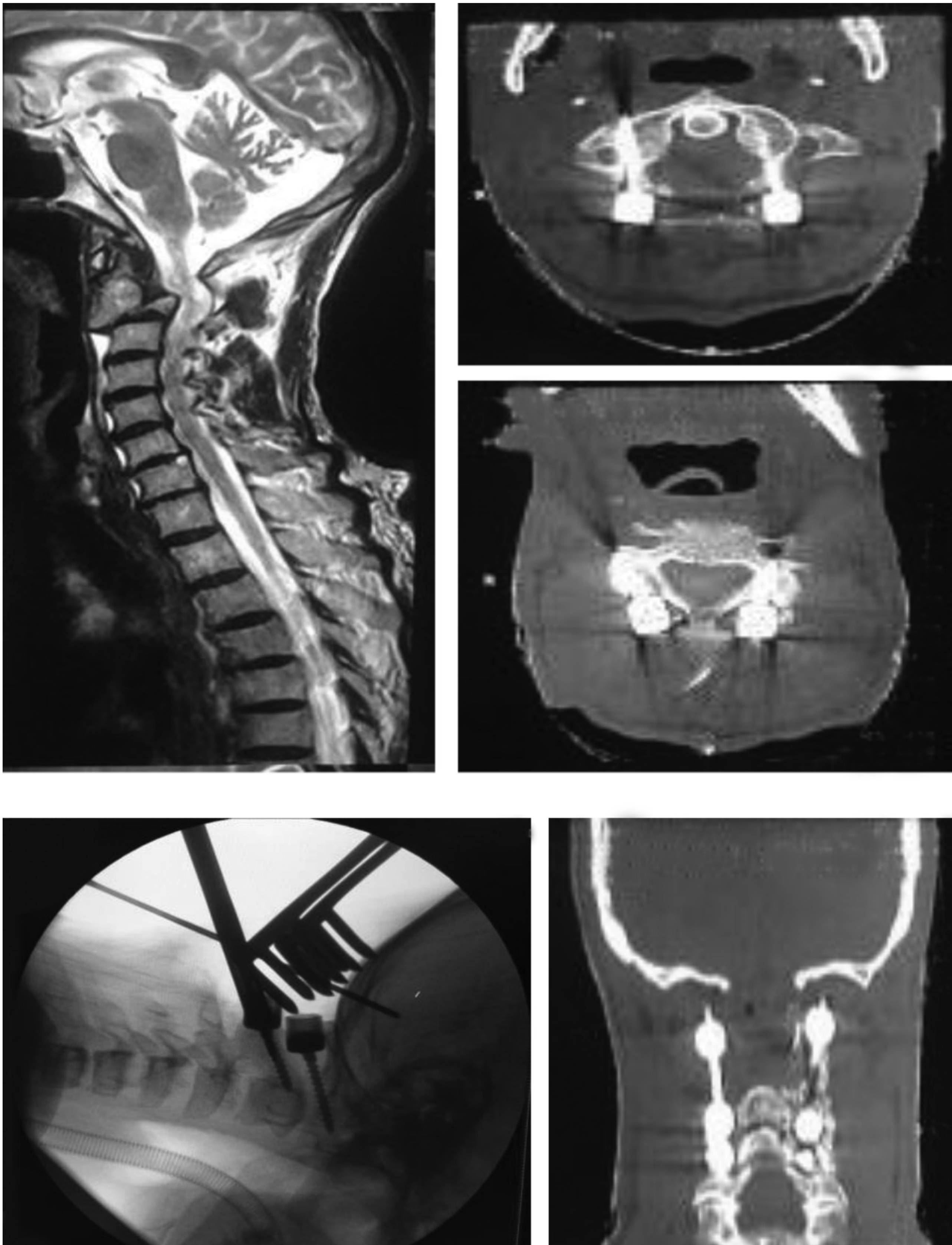

Fig. 2 Images of upper cervical spine injury operated by posterior approach.

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Results

Total study population comprised 36 patients of whom 33 (91.67%) were male and 3 (8.33%) were female (►**Table 1**). No significant difference was noticed between the sex distribution of patients with upper and lower cervical injury (►**Table 2**).

Statistical analysis was performed to measure association between sex and level of injury. No association ($p > 0.05$) was found between level of injury and patients' sex.

Most injuries in both population were caused by falls 23 (63.89%). Patients with upper cervical spine injury more likely to get trauma by fall than in case of lower cervical spine injury, but it did not show any statistical significant difference. In our study, patients with lower cervical spinal injuries are found to be more associated with higher energy mechanism as compared with upper cervical spine injury (►**Table 3**).

Out of 36 patients, 3 (8.33%) did not have any neurologic deficit, 29 (96.67%) out of 30 patients in lower cervical spine injury group had neurologic deficit, and 4 (66.67%) patients with upper cervical injury had neurologic deficit. Therefore, patients with upper spinal injuries were found to have fewer chances of neurologic deficit (►**Table 4**).

Table 1 Gender distribution

Level of injury	Sex		Total
	Male	Female	
Upper	5 83.33	1 16.67	6 100
Lower	28 93.33	2 6.67	30 100
Total	33 91.67	3 8.33	36 100

Note: Pearson's chi square = 0.6545, $p = 0.418$.

Table 2 Improvement in different sexes

Level of injury	Improvement and sex			
	No		Yes	
	Male	Female	Male	Female
Upper	1	–	4	1
Lower	–	1	28	1

Table 3 Mechanism of injury

Level of injury	Mechanism		Total
	Road Traffic	Fall	
Upper	2 33.33	4 66.67	6 100
Lower	11 36.67	19 63.33	30 100
Total	13 36.11	23 63.89	36 100

Note: Pearson's chi square = 0.0241, $p = 0.877$.

Table 4 Neurologic deficits in both groups

Level of injury	Neurodeficit		Total
	No	Yes	
Upper	2 33.33	4 66.67	6 100
Lower	1 3.33	29 96.67	30 100
Total	3 8.33	33 91.67	36 100

Note: Pearson's chi square = 5.8909, $p = 0.015$.

Table 5 Respiratory system involvement at various levels of injury

Level of injury	Respiratory involvement		Total
	No	Yes	
Upper	2 33.33	4 66.67	6 100
Lower	21 70.00	9 30.00	30 100
Total	23 63.89	13 36.11	36 100

Note: Pearson's chi square = 2.9137, $p = 0.088$.

Table 6 Mortality rates at both levels of injury

Level of injury	Mortality		Total
	No	Yes	
Upper	5 83.33	1 16.67	6 100
Lower	29 96.67	1 3.33	30 100
Total	34 94.44	2 5.56	36 100

Note: Pearson's chi square = 1.6941, $p = 0.193$.

In our study, 13 (36.11%) out of 36 patients were found to be involved respiratory system in upper cervical spine injuries, and 4 (66.67%) patients were found to be involved in respiration whereas 9 (30%) were found to have involvement of the same. However, this difference was not statistically significant (►**Table 5**).

Overall mortality was 2 (5.56%) for all patients with cervical spine injuries presenting to our tertiary care center. One (16.7%) patient died from upper cervical spine injuries and 1 (3.3%) from lower cervical spine injuries. This difference was not found to be statistically significant (►**Table 6**).

In our study, three (50%) out of six patients were found to present in duration of less than 1-week duration in upper cervical spine injury group. In lower cervical spine injury group, 23 (76.67%) out of 30 patients presented in less than 1-week duration. Whereas three (50%) of patients presented after 1-week duration in upper cervical spine injury group, seven (23.3%) presented after 1-week duration in lower

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Table 7 Duration of injury before surgery

Level of injury	Duration		Total
	< 1 wk	> 1 wk	
Upper	3 (50%)	3 (50%)	6 (100%)
Lower	23 (76.7%)	7 (23.3%)	30 (100%)
Total	26	10	36

cervical spine injury group. However, this difference was not statistically significant in both the groups (►**Table 7**).

Discussion

Our study comprised 36 patients of whom only 6 (16.67%) belonged to upper cervical spine injury group.The low percentage of upper cervical spine injury differs from the other previous studies. Age is an important factor for neurologic outcome and recovery. Although it involves mainly young age group, extreme of age is also not spared. In our study, 15 out of 36 patients belong to age group of ≤ 35 and 21 belong to age > 35 years. According to the National Statistical Center (NSCISC, Birmigham, Alabama, 2012), the average age of injury is 41 years with 80% SCIs in males. The most common etiology according to the NSCISC is road traffic accident (RTA) corresponding to 39%. In our study, 36.11% patients had cervical injury due to RTA and 63.89% due to fall.

In our study, incidence of lower cervical spine injury was 30 (84.35%) out of 36 patients, which was higher as compared with upper cervical injuries 6 (16.65%) out of 36 patients. The percentage of improvement was greater in lower cervical spine injury (96.57 vs. 83.35%) patients.

Controversy exists regarding the timing of surgery in SCI. Proponents of both early and late surgery can be found in the literature. Until now 22 studies attempted to define optimal timing of surgery for acute traumatic SCI, 9 used the 24-hour limit to define an early decompression,[8-16] 8 used 72-hour limit,[17-24] and 4 used other benchmarks such as 8 hours, 48 hours, or 4 days.[25-28] Interestingly, none of the studies have reported adverse neurologic outcomes with early surgical intervention.

All these studies have brought a paradigm shift in favor of early surgical intervention. The rationale behind this is based on the pathophysiology of acute SCI, indicating that there are both primary and secondary mechanisms that lead to neurologic injury. Preventing and mitigating the secondary mechanisms is where opportunity for neuroprotection lies and where most attempts at therapeutic intervention staged.

Fehlings et al in 2012 in a multicenter, international, prospective study (STASCIS [Surgical Timing in Acute Spinal Cord Injury Study] trial)[29] in adults aged 16 to 80 with cervical SCI concluded that decompression before 24 hours after injury is significantly associated with improved neurologic outcome at 6 months follow-up.

In this study, due to delay in referrals and poor respiratory status, there was a considerable delay before surgical decompression. Therefore, we categorized into two groups such as those operated within 7 days of injury considered as early surgical group and those were operated after 7 days considered as late surgical group. The percentage of patients died was 3.8% in early surgical group (≤ 7 days), whereas it was 10% in late surgical group (≥7 days), and it was statistically not significant.

Limitations of Study

The major limitation of this study was that it had a small sample size and a multivariate analysis was not possible as there was no group to compare on basis of mortality.

Conclusion

In this study, survival rates of patients with upper and lower cervical spine injuries were calculated on basis of mechanism of injury, preoperative neurologic status, respiratory involvement, and time of surgery following injury. Operative treatment of lower cervical injury was better associated with an improved outcome than upper cervical spine injuries. Further prospective study is required for better assessment, as statistically no significant difference was noted in our study due to small sample size.

Conflicts of Interest
None.

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