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# Initial ASIA impairment scale and its association with improvement in cervical spinal cord injury. Insights from a five-year retrospective study

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## ABSTRACT

**Background:** Cervical spinal cord injuries (SCI) are a severe subset of trauma cases, with important impacts on functional abilities and quality of life. Effective management strategies are crucial for improving outcomes.

**Objective:** This study evaluates the impact of initial ASIA impairment scale (AIS) grades on recovery and outcomes in cervical SCI.

**Methods:** A retrospective analysis of 565 patients with cervical SCI was conducted. Variables included age, gender, mode of injury, the timing of intervention, injury levels, management strategies, and outcomes based on initial and discharge AIS scores were analysed.

**Results:** The cohort comprised 565 patients, with age distribution as follows: 1-20 years (12.9%, n=73), 21-40 years (47.6%, n=269), 41-60 years (31.4%, n=177), and over 60 years (8.1%, n=46). Males predominated (86.9%, n=491). Age did not significantly affect outcomes ( $p=0.42$ ), and while males had a 28.5% good outcome rate, females had a 39.2% rate ( $p=0.06$ ). Road traffic accidents were the leading cause of injury (41.8%, n=236) but had a lower good outcome rate (22.9%) compared to falls (34.7%, n=196) with a higher good outcome rate (38.3%). Animal attacks showed the highest good outcome rate (66.7%, n=20). Timing of intervention did not significantly impact outcomes ( $p=0.16$  for injury-to-admission and  $p=0.793$  for timing of surgery). Subaxial cervical injuries were the most common (93.9%). Among 247 surgical patients, discectomy was most frequently performed. Complications occurred in 19.65% of patients, primarily pressure sores. The in-hospital mortality rate was 8.67%, with 79.47% discharged and 11.86% leaving against medical advice. Recovery was most pronounced in ASIA C (93.7%) and ASIA D (94.3%) patients. ASIA B patients showed a significant improvement rate (74.1%), while ASIA A patients had the lowest improvement (34.8%) ( $p<0.0001$ ).

**Conclusion:** Initial ASIA grades are strong predictors of neurological recovery in cervical SCI, with incomplete injuries (ASIA C and D) showing good outcomes. Management strategies, including early intervention and surgical approaches, play a crucial role in recovery. Despite some variability in outcomes based on injury cause and management, ASIA grading remains a critical tool for assessing prognosis and guiding treatment.

**Keywords**  
cervical spinal cord  
injuries,  
ASIA scale,  
outcomes,  
surgical management



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## INTRODUCTION

Trauma remains a leading cause of hospitalization worldwide, with spinal injuries representing a significant subset of trauma-related cases [1]. Cervical spinal cord injuries (SCI), though less frequent compared to other trauma types, are particularly severe due to their potential to cause profound and lasting disability [2]. Approximately 2.0–3.0% of all trauma patients sustain cervical SCI, and these injuries are responsible for about 8.2% of trauma-related mortalities. The severity of cervical SCI can lead to major functional impairments, affecting quality of life and survival of patients [3].

Effective emergency management of cervical SCI is crucial for optimizing outcomes. Key interventions include immediate immobilization of the cervical spine to prevent further injury, maintenance of adequate blood pressure and oxygenation to support spinal cord function, and rapid clinical and radiological assessment to identify the extent of the injury. Realignment of the spinal column is also critical to stabilize the injury and prevent secondary damage.

Definitive care of cervical SCI involves several important considerations. Recognizing the specific fracture patterns and assessing the level of spinal instability are essential for determining the appropriate treatment strategy [4]. Evaluating neurological deficits and considering other patient-specific factors, such as comorbid conditions or additional injuries, further guide the management approach [5]. The goals of surgical intervention typically include spinal realignment, decompression of neural structures, and stabilization through instrumentation to support healing and function.

Imaging plays a vital role throughout the management process. Initial and follow-up imaging are used to assess fracture healing and ensure that the spine remains stable following external immobilization, which typically lasts 8 to 12 weeks [6]. The imaging findings help guide decisions about whether surgical intervention is necessary and how to proceed with surgical planning.

The outcomes of cervical SCI are influenced by various factors, including the patient's age, Glasgow Coma Scale (GCS) score at the time of presentation, the extent of neurological impairment, and the presence of concomitant injuries or head trauma [7]. Despite advancements in treatment, many patients experience residual impairments, such as chronic

pain, limited range of motion, or other functional limitations.

This retrospective study aims to provide a comprehensive analysis of the presentation, radiological features, and management strategies for cervical spine injuries in trauma patients. Additionally, it explores the relationship between the initial ASIA (American Spinal Injury Association) grade at admission and patient outcomes over a five-year period. By examining these factors, the study seeks to enhance understanding of how initial neurological status correlates with long-term recovery and overall prognosis in cervical SCI cases.

## METHOD

### Study design and participants

This study reviewed medical records that met the predefined inclusion and exclusion criteria. Consent was obtained telephonically from patients or their legal guardians/caregivers. Data collected included socio-demographic details, clinical presentations, radiological findings, and ASIA Impairment Scale (AIS) scores at both admission and discharge, using a semi-structured data collection tool. The ASIA Impairment Scale (AIS) categorizes spinal cord injury severity into five grades:

AIS A (Complete): No sensory or motor function is preserved in the sacral segments S4-S5.

AIS B (Incomplete): Sensory function is preserved below the neurological level, including sacral segments S4-S5, but motor function is absent.

AIS C (Incomplete): Motor function is preserved below the neurological level, but more than half of the muscles below the injury have a muscle grade < 3.

AIS D (Incomplete): Motor function is preserved below the neurological level with at least half of the muscles showing a muscle grade of  $\geq 3$ .

AIS E (Normal): Sensory and motor functions are normal with no evidence of SCI.

### Clinical management

Patients with stable bony spinal injuries or cord contusions received conservative management. In contrast, those with unstable bony fractures, with or without cord compression, were treated surgically. Post-operative complications and outcomes, including survival and mortality, were documented. Improvement in AIS scores was assessed by noting

any increase in AIS grades from admission to discharge.

### Outcome measures

The primary outcome measure was the change in AIS score from admission to discharge. Secondary outcomes included post-operative complications, survival, and mortality (at home by telephonic).

### Data collection

Data were entered into Microsoft Excel spreadsheets, maintaining confidentiality for each participant. The dataset included variables such as socio-demographic information, clinical presentations, radiological findings, and AIS scores.

### Statistical analysis

Data analysis was conducted using SPSS version 21.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, summarized the data. The Kolmogorov-Smirnov test assessed the normality of data distribution. Categorical variables were analyzed using the chi-square test, while continuous variables were compared using the independent t-test or Mann-Whitney U test, depending on data distribution. Statistical significance was set at a 5% significance level ( $p < 0.05$ ).

### Ethics

The study was approved by the Institutional Ethical Committee and adhered to ethical standards throughout.

## RESULTS

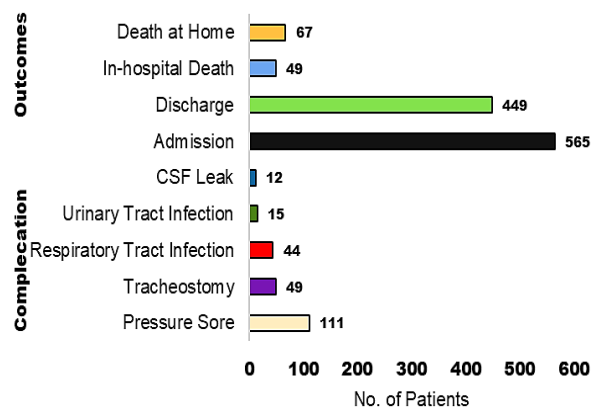
### Study population characteristics and outcomes

The study included 565 participants with mean age 37.46 ( $\pm 16.84$  and range 4-68) categorized by age as follows: 0-20 years (12.9%,  $n=73$ ), 21-40 years (47.6%,  $n=269$ ), 41-60 years (31.4%,  $n=177$ ), and over 60 years (8.1%,  $n=46$ ). There were no significant differences in outcomes across these age groups ( $p=0.42$ ). The sex distribution showed that 86.9% ( $n=491$ ) of the participants were male. Among these males, 28.5% ( $n=140$ ) had a good outcome, while 71.5% ( $n=351$ ) experienced a poor outcome. In contrast, 13.1% ( $n=74$ ) of the participants were female, with 39.2% ( $n=29$ ) achieving a good outcome and 60.8% ( $n=45$ ) a poor outcome ( $p=0.06$ ). The mode of injury had a significant impact on outcomes

( $p < 0.0001$ ). Road traffic accidents (RTA) represented 41.8% ( $n=236$ ) of cases, with only 22.9% ( $n=54$ ) showing a good outcome. Falls from height, accounting for 34.7% ( $n=196$ ) of cases, had a good outcome in 38.3% ( $n=75$ ) of cases. Injuries from animal attacks (5.3%,  $n=30$ ) had the highest proportion of good outcomes (66.7%,  $n=20$ ), while assaults (2.8%,  $n=16$ ) and other causes (15.4%,  $n=87$ ) had poorer outcomes (Table-1).

### Impact of injury to admission and surgery intervals on outcome

The interval between injury and admission did not significantly affect outcomes ( $p=0.16$ ). Good outcomes were observed in 40.8% ( $n=20$ ) of those admitted within a day, 26.4% ( $n=61$ ) within 2-3 days, 33.1% ( $n=58$ ) within 4-7 days, 23.5% ( $n=16$ ) within 8-15 days, and 33.3% ( $n=14$ ) after more than 15 days. Similarly, the interval from injury to surgery had no significant effect on outcomes ( $p=0.793$ ). Surgery performed within 6-24 hours resulted in a good outcome in 25.0% ( $n=1$ ) of cases, within 24-72 hours in 38.5% ( $n=5$ ), within 3-7 days in 34.8% ( $n=16$ ), and beyond 7 days in 41.3% ( $n=76$ ) (Table-2).



**Figure 1.** Distribution of cervical SCI patients on the basis of complications and outcomes.

### Level of injuries and type of management

The distribution of injuries among participants was as follows: 93.9% ( $n=531$ ) had subaxial cervical injuries, 4.4% ( $n=25$ ) had C1-C2 injuries, and 1.7% ( $n=9$ ) had Hangman's fractures (Fig 2A-C). Of the 247 operated patients, 45% ( $n=239$ ) had subaxial cervical injuries, 24.0% ( $n=6$ ) had C1-C2 injuries, and 22.3% ( $n=2$ ) had Hangman's fractures. Among the 318 non-operated patients, 55% ( $n=292$ ) had subaxial cervical injuries, 76.0% ( $n=19$ ) had C1-C2 injuries, and 77.7%

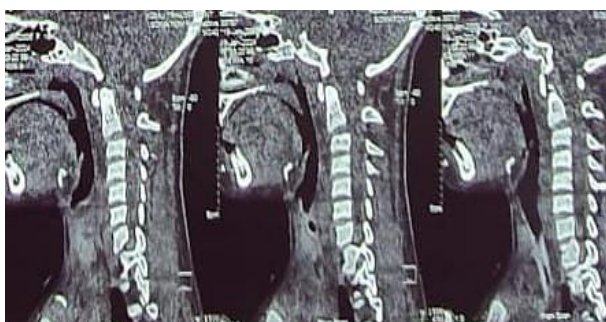
(n=7) had Hangman's fractures. The distribution of injuries by management type was significant ( $p=0.049$ ) (Table-3).



**Figure 2A.** Patient (17yr/M) with RTA with ASIA grade A involving subaxial (C4-C5 Listhesis) cervical spine injury.



**Figure 2B.** Patient (24 yr/M), ASIA grade E injury status with type 3 odontoid(C1-C2 type) fracture.



**Figure 2C.** Patient (16yr F) with fall from height, ASIA grade A injury with C2-C3 listhesis (Hangman)

### Complications and outcomes

Complications occurred in 19.65% (n=111) of patients, including pressure sores (19.65%), tracheostomy (8.67%), respiratory tract infections (7.79%), urinary tract infections (5.65%), and cerebrospinal fluid (CSF) leaks (2.12%). Regarding

outcomes, 79.47% (n=449) of participants were discharged, 8.67% (n=49) died in-hospital, and 11.86% (n=67) died at home (Fig.1).

### Neurological outcome by ASIA grade

At admission, neurological status was categorized as ASIA A (36.1%, n=204), ASIA B (23.9%, n=135), ASIA C (25.3%, n=143), ASIA D (12.6%, n=71), and ASIA E (2.1%, n=12). By discharge, improvements were noted in 27.6% (n=124) of ASIA A patients, 24.7% (n=111) of ASIA B patients, 30.1% (n=135) of ASIA C patients, 15.1% (n=68) of ASIA D patients, and 2.5% (n=11) of ASIA E patients. The improvement in neurological status was highly significant ( $p<0.0001$ ) (Table-4).

### Status of improvement based on asia grade at admission

For ASIA A at admission, 34.8% (n=71) improved, 25.9% (n=53) remained static, and 39.3% (n=80) expired or left against medical advice. Among ASIA B patients, 74.1% (n=100) improved, 8.2% (n=11) remained static, and 17.7% (n=24) expired or left against medical advice. In the ASIA C group, 93.7% (n=134) improved, 0.7% (n=1) remained static, and 5.6% (n=8) expired or left against medical advice. For ASIA D, 94.3% (n=67) improved, 1.4% (n=1) remained static, and 4.3% (n=3) expired or left against medical advice. Among ASIA E patients, 91.7% (n=11) remained static, and 1 left against medical advice. The association between ASIA grade at admission and improvement was highly significant ( $p<0.0001$ ) (Table-5).

### DISCUSSION

Spinal cord injury (SCI) is a debilitating condition that presents significant challenges, particularly in resource-limited settings. As noted in the literature, cervical spinal cord injuries (SCI) are among the most severe trauma-related injuries, often leading to substantial long-term disability or mortality [8]. The cervical spine is involved in approximately 50% of all spinal cord injuries, and injuries at or above the C3 level are particularly critical, often leading to severe impairment or death [9, 10].

In our study, which included 565 patients, the demographic and clinical characteristics were broadly consistent with previous research. The predominant age group was 21-40 years (47.6%), aligning with findings by Srinivas BH et al. [11], who

observed a similar age distribution in their study. The male predominance (86.9%) in our cohort mirrors patterns seen in other studies, highlighting the higher incidence of spinal cord injuries among males [12].

The mode of injury was a crucial factor influencing outcomes. Road traffic accidents (RTA) were the most common cause (41.8%), and these injuries were associated with poorer outcomes (22.9% good outcome). This is consistent with findings from other studies, which suggest that RTAs often involve severe trauma with complex injury patterns [13]. Falls, which accounted for 34.7% of cases, had a better outcome (38.3%), suggesting that these injuries may be less severe or more effectively managed [14]. Conversely, injuries from animal attacks showed the highest proportion of good outcomes (66.7%), potentially indicating less severe spinal involvement or more localized injuries.

Our analysis found no significant impact of the interval between injury and admission or the timing of surgery on outcomes ( $p=0.16$  and  $p=0.793$ , respectively). This is in line with some studies that suggest while timely intervention is crucial, its impact on outcomes may be less straightforward [15,16]. This might be due to variations in injury severity, patient health status, or the nature of the intervention.

In terms of injury levels and management, subaxial cervical injuries were the most common (93.9%), and there was a significant difference in management strategies ( $p=0.049$ ). Of those who underwent surgery, a majority had subaxial injuries, with discectomy being the most common procedure. This is consistent with Shah G *et al.* [12], who reported a similar prevalence of surgical interventions for cervical injuries. The preference for anterior discectomy over posterior approaches, despite its benefits, reflects current surgical trends and practices [14].

Complications were observed in 19.65% of patients, with pressure sores being the most frequent (19.65%). This finding underscores the need for effective prevention strategies in SCI patients, as pressure sores can significantly impact recovery and quality of life [17]. The in-hospital mortality rate of 8.67% was slightly higher than in some studies but lower than others [18]. This variation could be attributed to differences in patient demographics,

injury severity, and the presence of additional comorbidities.

Neurological outcomes were significantly influenced by the ASIA grade at admission. Patients with ASIA grades C and D showed considerable improvements, with 93.7% and 94.3% improving, respectively. This aligns with findings from Coleman and Geisler [17], who emphasized that incomplete injuries generally have a better prognosis than complete injuries. The significant recovery observed in ASIA B patients (74.1%) compared to ASIA A (34.8%) further supports the notion that the initial neurological status is a key predictor of recovery [18].

The study's limitations include its retrospective nature, which may introduce recall bias or misclassification errors. Additionally, the findings may not be generalizable beyond the specific tertiary care setting of the study. Prospective and longitudinal studies are needed to better assess predictors of recovery and long-term outcomes for cervical SCI patients.

## CONCLUSION

In summary, acute traumatic spinal cord injuries frequently affect young individuals and are primarily caused by falls and road traffic accidents, with cervical spine involvement being common. Delays in presentation and intervention can significantly impact outcomes. The severity of the injury and the appropriateness of intervention are crucial determinants of morbidity and mortality. Incomplete cervical injuries (ASIA Grades C and D) and injuries in the lower cervical regions (C5-C7) generally show better improvement compared to complete and upper cervical injuries (C4 and above). Effective management includes early immobilization, maintaining blood pressure and oxygenation, and prompt clinical assessment to optimize outcomes.

**Table 1.** General characteristics of study population.

Variables		Total Patients (n=565) N (%)	Good outcome (n=169) N (%)	Bad outcome (n=396) N (%)	p-value
Age (Years)	04-20	73(12.9)	18(24.7)	55(75.3)	0.420
	21-40	269(47.6)	76(28.3)	193(71.7)	
	41-60	177(31.4)	60(33.9)	117(66.1)	
	>60	46(8.1)	15(32.6)	31(67.4)	
Gender	Male	491(86.9)	140(28.5)	351(71.5)	0.061
	Female	74(13.1)	29(39.2)	45(60.8)	
Mode of Injury	RTA	236(41.8)	54(22.9)	182(77.1)	<0.0001*
	Fall	196(34.7)	75(38.3)	121(61.7)	
	Animal hit	30(5.3)	20(66.7)	10(33.3)	
	Assault	16(2.8)	6(37.5)	10(62.5)	
	#Others	87(15.4)	36(41.4)	51(58.6)	

#Fall On Ground – 22; Fall From Bed – 42; Fall Of Heavy Object On Head-15; Sports Injury-1; Machinery Injury-2. RTA; Road Traffic Accident. \*p<0.05 is statistically significant

**Table 2.** Association of injury to admission and surgery interval with outcomes

Variable		Patients N (%)	Good outcome (n=169) N (%)	Poor outcome (n=396) N (%)	p-value
Injury to admission interval (N=565)	< 1 Day	49(8.7)	20(40.8)	29(59.2)	0.161
	2-3 Days	231(40.8)	61(26.4)	170(73.6)	
	4-7 Days	175(30.9)	58(33.1)	117(66.9)	
	8-15 Days	68(12.1)	16(23.5)	52(76.5)	
	>15 Days	42(7.5)	14(33.3)	28(66.7)	
Injury to Surgery interval (N=247)	6-24 Hours	4(1.6)	1(25.0)	3(75.0)	0.793
	24-72 Hours	13(5.3)	5(38.5)	8(61.5)	
	3-7 Days	46(18.6)	16(34.8)	30(65.2)	
	>7 Days	184(74.5)	76(41.3)	108(58.7)	

**Table 3.** Type of injuries and management.

Type of Injury	Total patients n(%) (n=565)	Operated (n=247) n(%)	Non-operated n(%) (n=318)	p-value
Subaxial Cervical Injury	531 (93.9)	239 (45)	292 (55)	0.049
C1-C2 Injury	25 (4.4)	6 (24.0)	19 (76.0)	
Hangman's Fracture	9 (1.7)	2 (22.3)	7 (77.7)	

**Table 4.** Association of ASIA grades with (patients admission, discharge and death) outcomes.

ASIA Grades	Admission n(%)	Discharge n(%)	Hospital Death n(%)	Home Death n(%)
ASIA A	204 (36.1)	124(27.6)	42 (85.7)	38 (56.7)
ASIA B	135(23.9)	111 (24.7)	6(12.2)	18 (26.9)
ASIA C	143(25.3)	135(30.1)	1(2.1)	7(10.5)

ASIA D	71(12.6)	68 (15.1)	0 (0.0)	3 (4.5)
ASIA E	12(2.1)	11(2.5)	0 (0.0)	1 (1.5)
p-value	<0.0001*		na	

**Table 5.** Association of ASIA grade with status of patients.

ASIA grade at Admission	ASIA grade status at Discharge			p-value
	Improved	Stable	Expired	
A (N=204)	71 (34.8)	53 (25.9)	80 (39.3)	<0.0001
B (N=135)	100 (74.1)	11 (8.2)	24 (17.7)	
C (N=143)	134 (93.7)	1 (0.7)	8 (5.6)	
D (N=71)	67 (94.3)	1 (1.4)	3 (4.3)	

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