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Neurological Recovery after Surgical Intervention in Patients with Traumatic Spinal Cord Injury (SCI): A Single Centre Experience

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ABSTRACT

Objective: To determine the frequency of neurological recovery in patients with traumatic spinal cord injuries (SCI) following surgical intervention at the Department of Orthopaedics & Spine Surgery, Hayatabad Medical Complex, Peshawar.
Methodology: This a retrospective, cross-sectional study conducted from June 2016 to June 2024. A total of 354 patients with traumatic SCI who underwent surgical intervention were included. Data were collected from hospital records and analyzed using the ASIA (American Spinal Injury Association) grading system for neurological outcomes. Statistical analysis was performed using SPSS, with a significance level of $p < 0.05$.
Results: Out of 354 patients, 270 (76.3%) were male, and 84 (23.7%) were female, with a mean age of 31.81 years (SD ± 13.31). Falls from height were the leading cause of injury (63.6%). Neurological recovery, defined as an improvement of at least one ASIA grade, was observed in 268 (75.7%) patients. Among patients with ASIA A, 17.53% showed improvement, while 86.66% of ASIA B, 83.04% of ASIA C, and 43.7% of ASIA D patients experienced neurological improvement post-surgery.
Conclusion: The study findings underscore the significant potential for neurological recovery following surgical intervention in SCI patients, particularly in those with incomplete injuries. The results highlight the importance of early and tailored surgical management for optimal recovery.

INTRODUCTION

Traumatic SCI is a catastrophic event that often leads to long-term neurological deficits, and its management remains a challenge worldwide. Surgical intervention is frequently required to mitigate the damage and promote neurological recovery. Research indicates that the timing of the surgical intervention plays a crucial role in patient outcomes. While studies have shown the potential benefits of early surgical decompression, the extent and predictability of neurological recovery post-surgery still present a multifactorial challenge.[1] This study aims to explore the frequency and predictors of neurological recovery in traumatic SCI patients at the Department of Orthopaedics & Spine Surgery, Hayatabad Medical Complex, Peshawar.

Early surgical decompression, particularly within 12 hours of injury, has been a topic of substantial interest. Some studies have

demonstrated improved neurological outcomes with early decompression, though others indicate mixed results depending on the location and severity of the injury. For example, a systematic review and meta-analysis reported that early decompression, defined as surgery performed within 24 hours of injury, was associated with favorable neurological recovery.[2] However, its effectiveness appears to vary by injury type, with greater improvements noted in cervical SCI compared to thoracic or lumbar injuries.[3]

Further studies have indicated that neurological recovery is significantly enhanced in patients who undergo surgery within 8 hours of the injury, particularly those with complete SCI. For instance, a meta-analysis found that urgent decompression within 8 hours led to substantial improvements in American Spinal Injury Association (ASIA) scores, especially in patients with complete SCI.[4]

The role of early surgical intervention in SCI recovery continues to be supported by evidence indicating that early decompression can lead to better neurological outcomes. A study by Haldrup et al. (2019) in Western Denmark showed that decompression within 24 hours of the trauma significantly improved neurological outcomes in patients with incomplete SCI.[5] Similarly, Hsieh et al. (2021) observed that early surgical decompression had a more favorable impact on neurological recovery compared to late decompression across various subgroups of SCI patients.[6]

Interestingly, studies focusing on Pakistani populations have provided valuable insights into local trends in SCI management. Research from tertiary care centers in Pakistan suggests that early surgical decompression, coupled with aggressive rehabilitation, significantly improves neurological recovery in SCI patients.[7]

Given the increasing global and local evidence supporting early intervention, this study aims to provide insights into neurological recovery following surgical intervention in traumatic SCI patients. The study is particularly relevant in the context of a single-center experience at Hayatabad Medical Complex, Peshawar, where resources and access to timely intervention might differ from global standards. Understanding the frequency of neurological recovery in this specific population will contribute to the growing body of literature on SCI management in resource-limited settings.

The objective of this study was to determine the frequency of neurological recovery in patients with traumatic SCI following surgical intervention at the Department of Orthopaedics & Spine Surgery, Hayatabad Medical Complex, Peshawar.

MATERIALS AND METHODS

This cross-sectional study was conducted at the Department of Orthopaedics & Spine Surgery, Hayatabad Medical Complex, Peshawar. The data collection period spanned from June 2016 to June 2024. The study was retrospective in nature, utilizing data from the hospital's records of patients admitted with traumatic SCI who underwent surgical intervention during this period.

To determine the sample size, we referred to studies that examined surgical interventions in patients with SCI. A previous study by Goh et al. (2022) analyzed a large cohort of 961 patients with gunshot-induced spinal injuries and demonstrated significant neurological improvements following surgical intervention, particularly in thoracic and lumbar injuries. This study provides a robust reference for large-scale studies in SCI surgical outcomes, reinforcing the relevance of using larger sample sizes for meaningful statistical analysis.[8] Based on this reference, and assuming a confidence level of 95% with a 5% margin of error, our study will include 674 patients to evaluate neurological recovery post-surgery.

Inclusion Criteria

Patients included in this study were those who presented with traumatic spinal cord injuries and were admitted for surgical management at our department. The inclusion criteria required that these patients had undergone surgical intervention to manage their SCI.

Exclusion Criteria

The following exclusion criteria were applied:

- Patients with fractures at the atlantoaxial joint (FAI).
- Patients with soft tissue injuries without bony involvement.
- Patients who were treated conservatively due to fitness concerns or medical contraindications for surgery.

- Patients with multilevel fractures that were managed without surgical intervention.

Data were collected from the hospital's electronic medical records and patient charts. The collected data included demographic details, mechanism of injury, level and severity of SCI (as determined by the American Spinal Injury Association Impairment Scale - ASIA), timing of surgery, type of surgical procedure, and neurological outcomes. Neurological recovery was assessed based on the ASIA motor and sensory score at admission and at follow-up visits (six months and one year post-surgery).

Definitions and Assessment Criteria

- Neurological Recovery: Defined as any improvement in ASIA grade from baseline to follow-up. A meaningful recovery was considered as a change of at least one grade on the ASIA Impairment Scale.
- Surgical Timing: Early surgery was defined as surgical intervention performed within 24 hours of injury, while late surgery was defined as intervention occurring more than 24 hours after injury.
- Outcome Variables: Primary outcomes included improvement in motor function and sensory recovery as measured by ASIA score.

Data analysis was conducted using SPSS version 25. Descriptive statistics, including means, medians, and standard deviations, were calculated for continuous variables, while categorical variables were reported as frequencies and percentages. Comparisons between groups (early vs. late surgery) were made using chi-square tests for categorical variables and t-tests for continuous variables. A p-value of less than 0.05 was considered statistically significant. Multivariate logistic regression was performed to assess the predictors of neurological recovery.

Ethical approval for this study was obtained from the Ethical and Research Committee of the Hayatabad Medical Complex, Peshawar. All patient data were anonymized to ensure confidentiality. Since this was a retrospective study, informed consent was obtained from patients or their guardians during their hospital stay, authorizing the use of their medical data for research purposes.

RESULTS

During the study period, a total of 674 patients with spinal injuries were treated at our department. Of these, 354 patients presented with neurological deficits and met the inclusion criteria, and were therefore included in the study. The demographic and injury-related details of the patients are summarized in Table 1.

Table 1

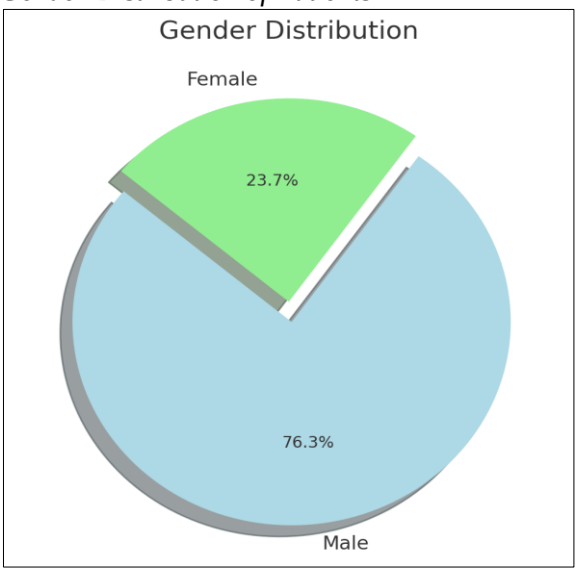
Patient Demographics and Injury Overview (n=674)

Category	Numbers	Percentage
Total Patients	674	
Included Patients	354	
Male	270	76.30%
Female	84	23.70%
Mean Age (years)	31.81 Â± 13.31	
Falls	225	63.60%
RTA	129	36.40%

The majority of the patients were male, accounting for 270 out of 354 patients (76.3%), while 84 patients (23.7%) were female, as shown in Figure 1. The ages of the patients ranged from 9 to 80 years, with a mean age of 31.81 years (SD ± 13.31). The most common cause of spinal cord injury (SCI) was falls from height, which affected 225 patients (63.6%), followed by road traffic accidents (RTA), which accounted for 129 cases (36.4%).

Figure 1

Gender Distribution of Patients



Regarding the location of spinal injuries, 83 patients (23.4%) had cervical spine injuries, 137 patients (38.7%) had dorsal spine injuries, and 134 patients (37.9%) had lumbar spine injuries. The types of fractures were classified according to the AO fracture classification system, with 13 patients (3.7%) having type A fractures, 177 patients (50%) having type B fractures, and 164 patients (46.3%) having type C fractures.

At presentation, the neurological status of the patients was assessed using the ASIA (American Spinal Injury Association) grading system. As shown in Table 2, the distribution was as follows: 154 patients (43.5%) were classified as ASIA A (complete neurological deficit), 30 patients (8.5%) as ASIA B, 145 patients (41%) as ASIA C, and 25 patients (7.1%) as ASIA D.

Table 2

Neurological Status at Presentation (ASIA Grades) (n=674)

ASIA Grade	Number of Patients	Percentage
A (Complete Deficit)	154	43.50%
B	30	8.50%
C	145	41%
D	25	7.10%

After surgical intervention, neurological outcomes at the last follow-up visit showed significant improvements. Overall, 268 out of 354 patients (75.7%) experienced an improvement of at least one grade in the ASIA classification. Table 3 shows the detailed post-surgical improvement in each ASIA grade. Among the 154 patients with ASIA A neurology, 27 patients (17.53%) improved by one grade. In the ASIA B group, 26 out of 30 patients (86.66%) showed improvement. In the ASIA C group, 142 out of 145 patients (83.04%) improved neurologically, and in the ASIA D group, 73 out of 25 patients (43.7%) improved to ASIA E (normal neurological function). The changes in neurological status before and after surgery are illustrated in Figure 2.

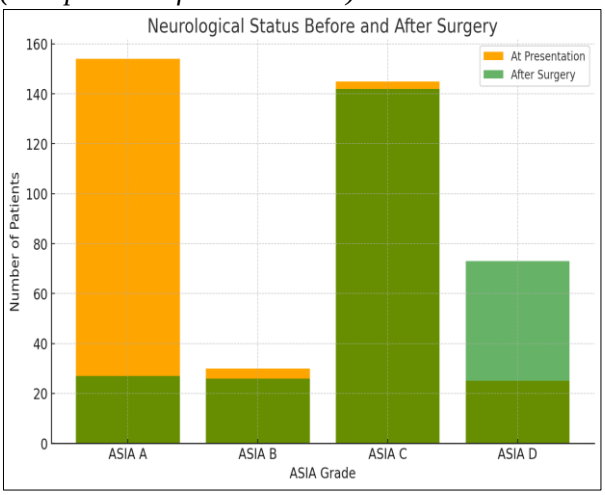
Table 3

Neurological Status After Surgery (ASIA Grades) (n=674)

ASIA Grade	Improved Patients	Improvement Percentage
A (Complete Deficit)	27	17.53%
B	26	86.66%
C	142	83.04%
D	73	43.70%

Figure 2

Neurological Status Before and After Surgery (Comparison of ASIA Grades)



The type of fracture was found to have a strong correlation with the severity of neurological impairment. Patients with type C fractures had the highest incidence of complete neurological deficits (ASIA A), while those with type A fractures exhibited the lowest incidence of complete deficits.

DISCUSSION

This study is one of the few to evaluate neurological recovery after surgical intervention for SCI in a Pakistani population. Although several studies have explored SCI outcomes globally, there is a significant lack of research on this topic within Pakistan. The uniqueness of this study lies in its localized focus, contributing novel data from the Department of Orthopaedics & Spine Surgery, Hayatabad Medical Complex. Similar studies have been conducted internationally, particularly in regions like India and Europe, where large-scale studies have been done on neurological recovery following SCI surgery.[9] However, very few local studies have comprehensively addressed the neurological recovery of SCI patients after surgical interventions in Pakistan.[10]

The neurological improvement observed in 75.7% of our patients is consistent with findings from international studies, where similar outcomes were reported for SCI patients undergoing surgery. Studies from India and Europe have shown significant recovery rates in patients receiving

surgical interventions within specific time frames, with a similar percentage of patients improving by at least one grade on the ASIA scale.[2] In our study, 83.04% of patients with ASIA C showed significant improvement, aligning with reports indicating favorable outcomes in incomplete SCI cases.[1]

The male predominance in our study (76.3%) and the age distribution (mean age of 31.81 years) reflect global trends in SCI demographics. Studies consistently show that males are disproportionately affected by SCI, often due to higher exposure to risk factors like falls and road traffic accidents.[8] Similarly, the mean age of patients in other international studies often falls between 30 and 40 years, comparable to our findings.

Our study demonstrated that the type of fracture had a strong relationship with neurological outcomes, with type C fractures associated with the highest incidence of complete neurological deficits (ASIA A). This aligns with findings in the literature that suggest more severe fractures tend to result in worse neurological outcomes.[11] Furthermore, early surgical intervention is shown to improve outcomes significantly, which is consistent with other studies that highlight the benefits of surgery performed within 24 hours of injury.[12]

Our findings reinforce the importance of timely surgical intervention and its role in enhancing neurological recovery. The high percentage of patients showing improvement in ASIA grades, particularly in those with incomplete SCIs (ASIA B and C), emphasizes the potential for positive neurological recovery in these groups. The significantly better outcomes observed in patients with less severe fractures (Type A and B) compared to Type C fractures also underscore the impact of injury severity on recovery prospects.

Study Limitations

Despite the encouraging results, there are several limitations to our study. First, this was a retrospective analysis, and thus, we were limited by the availability and accuracy of medical records. Furthermore, follow-up data was available only up to one year post-surgery, which may not fully capture long-term outcomes.

Future Directions

Further research is needed to explore the long-term outcomes of SCI patients following surgical interventions in Pakistan. Expanding this study to a multi-center cohort would provide a broader perspective on neurological recovery and allow for comparisons across different hospital settings. Moreover, examining the role of early rehabilitation in conjunction with surgical treatment could offer deeper insights into maximizing functional recovery in SCI patients.

CONCLUSION

In this study, we assessed the frequency and outcomes of neurological recovery in patients with traumatic SCI after surgical intervention at our center. Our results demonstrate that a significant proportion of patients (75.7%) experienced improvement in their ASIA grade following surgery, particularly those with incomplete injuries. These findings highlight the critical role of timely surgical intervention in promoting neurological recovery. The relationship between fracture type and neurological deficit further emphasizes the need for tailored surgical strategies based on injury severity. This study contributes valuable insights to the local and global understanding of SCI management and reinforces the importance of early surgical intervention for optimal outcomes.

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