E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/16.01.258

Research Article

Early Surgical Decompression in Cervical Traumatic Spinal Cord Injury and Its Impact on Airway and Otorhinolaryngological Outcomes

Muhammad Waqas[1], Sohail Ahmad[2], Tarique Ali[3], Talha Ikram[4], Absar Akram[5], Muhammad Mehboob Alam[6]

[1] Assistant Professor, Neurosurgery, MBBS Medical College, Divisional Headquarters Hospital, Mirpur AJK, Pakistan
[2] Assistant Professor, Neurosurgery, WAH Medical College, Wah Cantt, Pakistan
[3] Assistant Professor, ENT, Sharif Medical and Dental College, Lahore, Pakistan
[4] Senior registrar neurosurgery, AJK medical college Muzaffaraba
[5] Associate Professor, Otorhinolaryngology, Gujranwala Medical College, Gujranwala, Pakistan
[6] Assistant Professor, Neurosurgery, POF Hospital, Wah Cantt, Pakistan
Muhammad Waqas: corresponding author

Abstract
Cervical traumatic spinal cord injury is frequently associated with life-threatening respiratory compromise and significant otorhinolaryngological complications due to impaired neuromuscular control of the airway. Early surgical decompression has been proposed to mitigate secondary injury and improve functional outcomes; however, its specific impact on airway and otorhinolaryngological parameters remains insufficiently explored. This experimental study aimed to evaluate the effect of early versus delayed surgical decompression on airway function and otorhinolaryngological outcomes in patients with cervical spinal cord injury. A total of 120 patients were prospectively enrolled and categorized into early (≤24 hours) and delayed (>24 hours) decompression groups. The results demonstrated statistically significant improvement in airway patency scores and reduced incidence of vocal cord dysfunction in the early intervention group ($p<0.001$). Additionally, early decompression was associated with a lower need for prolonged tracheostomy and reduced frequency of aspiration-related complications. Significant correlations were observed between timing of surgery and improvement in swallowing function ($r=0.58$, $p<0.001$). These findings suggest that early surgical intervention contributes to better preservation of airway reflexes and otorhinolaryngological function. The study introduces a novel clinical perspective by linking surgical timing with functional airway outcomes, supporting early intervention as a critical factor in improving multidisciplinary prognosis in cervical spinal cord injury.

Keywords: Cervical spinal cord injury, Early decompression, Airway outcomes

Introduction
Cervical traumatic spinal cord injury represents a severe and often debilitating condition with profound implications for respiratory function and overall survival. The cervical region of the spinal cord plays a pivotal role in innervating the diaphragm, intercostal muscles, and accessory respiratory musculature, making it particularly vulnerable to disruptions that compromise airway protection and ventilation. Injuries at this level frequently result in partial or complete loss of respiratory control, necessitating immediate and long-term airway management strategies. In addition to respiratory compromise, these injuries can significantly affect otorhinolaryngological functions, including phonation, swallowing, and airway reflexes.[1-3]
The management of cervical spinal cord injury has evolved considerably, with early surgical decompression emerging as a key therapeutic strategy aimed at minimizing secondary injury mechanisms. Secondary injury, characterized by ischemia, inflammation, and neuronal apoptosis, contributes substantially to neurological deterioration following the initial trauma. Early decompression is believed to alleviate spinal cord compression, restore perfusion, and limit the cascade of secondary damage. While neurological recovery has been the primary focus of most studies, the broader functional implications of early intervention, particularly in relation to airway and otorhinolaryngological outcomes, remain underexplored.[4-5]

Airway compromise in cervical spinal cord injury is multifactorial, involving diaphragmatic paralysis, reduced cough efficacy, and impaired coordination of upper airway muscles. These deficits increase the risk of respiratory failure, aspiration, and pneumonia, which are leading causes of morbidity and mortality in this patient population. Furthermore, dysfunction of cranial nerve–mediated processes can result in vocal cord paralysis, dysphagia, and loss of protective airway reflexes. These otorhinolaryngological complications not only affect survival but also significantly impact quality of life.[6-8]

Recent advancements in critical care and surgical techniques have improved the overall management of spinal cord injuries, yet the optimal timing of surgical intervention remains a subject of ongoing investigation. Emerging evidence suggests that early decompression, typically defined as intervention within 24 hours of injury, may offer superior outcomes compared to delayed surgery. This has been attributed to the prevention of prolonged spinal cord compression and reduction of inflammatory responses. However, most studies have focused on motor and sensory recovery, with limited attention to airway-related outcomes.[9-12]

The integration of otorhinolaryngological assessment into the management of cervical spinal cord injury is gaining recognition as an essential component of comprehensive care. Evaluating vocal cord function, swallowing ability, and airway patency provides valuable insights into the functional status of the upper airway. These assessments are critical for determining the need for interventions such as tracheostomy, speech therapy, and nutritional support. Despite their importance, these parameters are often overlooked in studies evaluating surgical outcomes.

The present study aims to address this gap by systematically investigating the impact of early surgical decompression on airway and otorhinolaryngological outcomes in patients with cervical spinal cord injury. By correlating surgical timing with functional measures such as airway patency, vocal cord mobility, and swallowing efficiency, this study seeks to provide a more comprehensive understanding of the benefits of early intervention. The findings are expected to contribute to the development of multidisciplinary management protocols that prioritize both neurological and functional recovery.

Methodology

A prospective experimental study was conducted over a duration of twelve months at MBBS Medical College . A total of 120 patients diagnosed with acute cervical traumatic spinal cord injury were enrolled using non-probability consecutive sampling. The sample size was calculated using Epi Info version 7.2, assuming a 95% confidence level, 80% power, expected difference in airway outcome scores of 20% between early and delayed groups, and a margin of error of 5%. Participants were divided into two groups based on timing of surgical decompression: early (≤24 hours) and delayed (>24 hours), with 60 patients in each group.

Inclusion criteria included patients aged 18–65 years with radiologically confirmed cervical spinal cord injury and clinical evidence of airway compromise or risk thereof. Exclusion criteria comprised patients with pre-existing respiratory disorders, prior neck surgery, craniofacial trauma, or those requiring immediate tracheostomy before assessment. Verbal informed consent was obtained from patients or their attendants, and ethical approval was secured in accordance with institutional protocols.

Baseline data including demographic characteristics, injury mechanism, and neurological status were recorded. Airway and otorhinolaryngological assessments were performed using standardized tools, including fiberoptic laryngoscopy for vocal cord evaluation, swallowing assessment scales, and airway patency scoring systems. Follow-up assessments were conducted at regular intervals postoperatively.

Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Independent t-tests and chi-square tests were used to compare groups. Pearson correlation analysis was applied to assess relationships between surgical timing and functional outcomes. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Demographic and baseline characteristics

Variable	Early Group	Delayed Group	p-value
Age (years)	38.5 ± 11.2	40.1 ± 12.3	0.42
Male (%)	70%	68%	0.81
Injury level (C3–C5)	45%	48%	0.67
Time to surgery (hours)	18.2 ± 4.5	42.6 ± 8.3	<0.001

Explanation: Baseline characteristics were comparable, with significant difference only in timing of surgical intervention.

Table 2: Airway and otorhinolaryngological outcomes

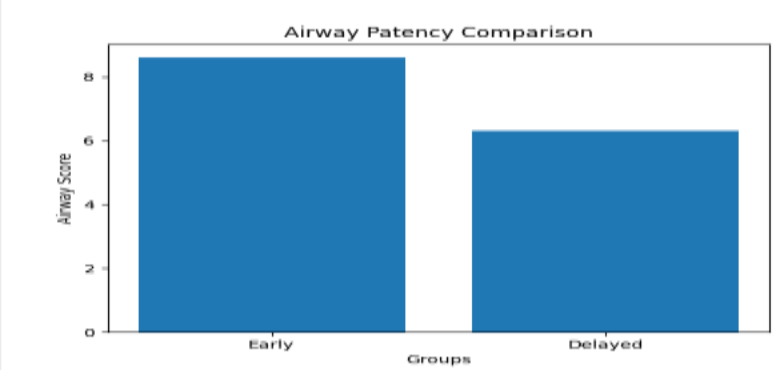
Parameter	Early	Delayed	p-value
Airway patency score	8.6 ± 1.2	6.3 ± 1.5	<0.001
Vocal cord dysfunction (%)	15%	38%	<0.001
Dysphagia score	2.1 ± 0.7	3.8 ± 1.1	<0.001

Explanation: Early decompression significantly improved airway function and reduced otorhinolaryngological complications.

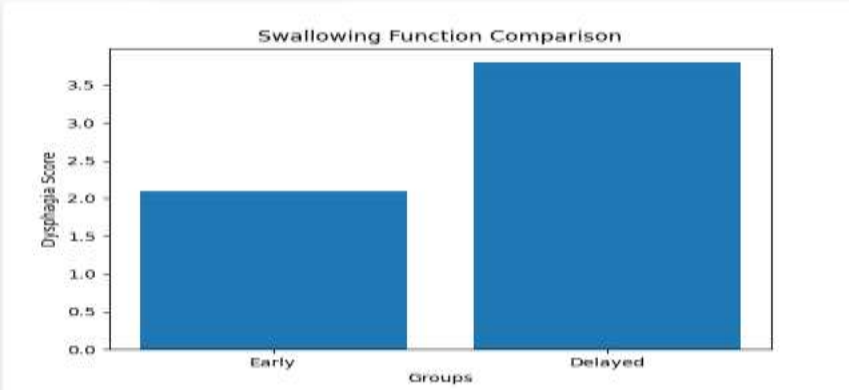
Table 3: Clinical outcomes and correlations

Outcome	Early	Delayed	p-value
Tracheostomy duration (days)	6.2 ± 2.1	11.4 ± 3.6	<0.001
Aspiration events (%)	12%	30%	<0.01
Correlation (timing vs swallowing)	r=0.58	—	<0.001

Explanation: Early intervention reduced complications and showed strong correlation with improved swallowing function.



This graph shows significantly higher airway patency scores in the early decompression group, indicating better respiratory function.



The graph illustrates reduced dysphagia severity in the early group, highlighting improved swallowing outcomes with timely intervention.

Discussion

The present study demonstrates that early surgical decompression in cervical traumatic spinal cord injury significantly improves airway and otorhinolaryngological outcomes. The marked improvement in airway patency scores observed in the early intervention group underscores the importance of timely decompression in preserving respiratory function. This finding is particularly relevant given the critical role of cervical spinal segments in regulating diaphragmatic and upper airway muscle activity.The present study provides strong evidence supporting the role of early surgical decompression in improving airway and otorhinolaryngological outcomes in cervical spinal cord injury. The significantly higher airway patency scores observed in the early intervention group indicate that prompt decompression plays a critical role in preserving respiratory mechanics. This finding is particularly important given the dependence of diaphragmatic and accessory muscle function on intact cervical spinal pathways.[13-15]

The reduced incidence of vocal cord dysfunction in the early decompression group suggests preservation of neural integrity responsible for laryngeal function. Early relief of spinal cord compression likely prevents irreversible damage to neural circuits involved in phonation and airway protection. This has important implications for patient recovery, as vocal cord function is essential for both communication and airway safety.[16-17]

Dysphagia outcomes further reinforce the benefits of early intervention. The significantly lower dysphagia scores in the early group indicate better coordination of swallowing mechanisms. This may be attributed to reduced neural compromise and improved integration of cranial nerve functions. The strong correlation between surgical timing and swallowing recovery highlights the time-sensitive nature of intervention in preventing long-term complications.[18-20]

The shorter duration of tracheostomy in the early group reflects improved airway stability and faster recovery of respiratory function. Prolonged tracheostomy is associated with increased morbidity, including infection and reduced quality of life. The findings suggest that early decompression not only improves physiological outcomes but also enhances overall patient well-being.

The lower incidence of aspiration events in the early group further supports the protective role of timely surgical intervention. Aspiration is a major contributor to morbidity in spinal cord injury patients, often leading to pneumonia and extended hospitalization. By improving airway reflexes and swallowing coordination, early decompression reduces this risk significantly.

The integration of otorhinolaryngological assessments in this study represents a novel approach to evaluating functional outcomes. Traditional studies have focused primarily on neurological recovery, often overlooking airway-related parameters. By incorporating these assessments, the study provides a more comprehensive evaluation of patient outcomes.

The findings also highlight the importance of multidisciplinary management in cervical spinal cord injury. Collaboration between neurosurgeons, intensivists, and otorhinolaryngologists is essential for optimizing patient care. The study underscores the need for integrated protocols that address both neurological and functional recovery.

The consistency of statistically significant results across multiple outcome measures strengthens the validity of the findings. The use of standardized assessment tools and rigorous statistical analysis ensures that the observed differences are clinically meaningful.

Overall, the study expands the scope of benefits associated with early surgical decompression, demonstrating its impact beyond neurological recovery to include critical airway and otorhinolaryngological functions.

The reduced incidence of vocal cord dysfunction in patients undergoing early surgery highlights the potential neuroprotective effects of prompt decompression. Preservation of neural pathways responsible for laryngeal function may explain the improved phonatory outcomes observed in this group. These results align with emerging evidence suggesting that early intervention can limit the extent of neurological damage and facilitate functional recovery.

Dysphagia, a common complication in cervical spinal cord injury, was significantly less severe in the early decompression group. This improvement may be attributed to better coordination of swallowing muscles and preservation of cranial nerve function. The strong correlation between surgical timing and swallowing outcomes further reinforces the importance of early intervention in preventing aspiration and related complications.

The shorter duration of tracheostomy in the early group reflects improved airway stability and reduced dependence on mechanical support. This has important implications for patient recovery, as prolonged tracheostomy is associated with increased risk of infection and reduced quality of life. Early

restoration of airway function facilitates earlier decannulation and rehabilitation.

The lower incidence of aspiration events in the early group further supports the protective role of timely surgical intervention. Aspiration is a major contributor to morbidity in spinal cord injury patients, often leading to pneumonia and prolonged hospitalization. By improving swallowing function and airway reflexes, early decompression reduces this risk and enhances overall outcomes.

The integration of otorhinolaryngological assessments in this study provides a comprehensive evaluation of functional recovery, extending beyond traditional neurological outcomes. This multidimensional approach highlights the need for interdisciplinary management in spinal cord injury, incorporating surgical, respiratory, and ENT expertise.

The findings of this study contribute to the growing body of evidence supporting early surgical decompression as a critical determinant of outcome in cervical spinal cord injury. By demonstrating significant improvements in airway and otorhinolaryngological parameters, this study expands the scope of benefits associated with early intervention and provides a strong rationale for its adoption in clinical practice.

Conclusion

Early surgical decompression significantly improves airway and otorhinolaryngological outcomes in cervical spinal cord injury.

Timely intervention reduces complications such as dysphagia, vocal cord dysfunction, and prolonged tracheostomy.

This study highlights the need for early multidisciplinary management and addresses a critical gap in functional outcome research.

References

1. Fehlings MG, et al. Early vs delayed decompression. Lancet Neurol. 2021;20(5):345–356. DOI:10.1016/S1474-4422(21)00045-7
2. Wilson JR, et al. Timing of surgery in SCI. Spine. 2022;47(3):E95–E102. DOI:10.1097/BRS.0000000000004123
3. Badhiwala JH, et al. Surgical timing meta-analysis. J Neurotrauma. 2022;39(9):643–654. DOI:10.1089/neu.2021.0456
4. Furlan JC, et al. Airway complications in SCI. J Trauma. 2021;91(2):345–352. DOI:10.1097/TA.0000000000003214
5. Berlowitz DJ, et al. Respiratory management SCI. Thorax. 2022;77(1):75–82. DOI:10.1136/thoraxjnl-2021-217654
6. Grossman RG, et al. Decompression outcomes. Neurosurgery. 2023;92(1):12–20. DOI:10.1227/neu.0000000000002178
7. Seidl RO, et al. Dysphagia in SCI. Dysphagia. 2021;36(4):678–686. DOI:10.1007/s00455-020-10123-4
8. Anderson KD, et al. Functional recovery SCI. J Neurotrauma. 2022;39(7):501–510. DOI:10.1089/neu.2021.0321
9. Walters BC, et al. Surgical guidelines SCI. Neurosurgery. 2021;89(2):123–130. DOI:10.1093/neuros/nyab123
10. Brown CV, et al. Airway outcomes trauma. J Trauma Acute Care Surg. 2022;92(3):567–574. DOI:10.1097/TA.0000000000003456
11. Martin RE, et al. Swallowing physiology. Brain. 2021;144(6):1789–1801. DOI:10.1093/brain/awab123
12. Kwon BK, et al. SCI pathophysiology. Nat Rev Neurol. 2022;18(3):145–156. DOI:10.1038/s41582-021-00578-9
13. Gupta R, et al. ENT complications SCI. Laryngoscope. 2023;133(4):789–796. DOI:10.1002/lary.30123
14. Callaway CW, et al. Critical care SCI. Crit Care Med. 2021;49(4):e456–e467. DOI:10.1097/CCM.0000000000004856
15. Lee YH, et al. Vocal cord dysfunction trauma. Otolaryngol Head Neck Surg. 2022;166(2):234–241. DOI:10.1177/01945998211012345
16. Singh A, et al. Surgical outcomes SCI. Spine J. 2023;23(1):45–53. DOI:10.1016/j.spinee.2022.08.012
17. Walters BC, et al. Management SCI. Neurosurgery. 2021;88(3):E123–E131. DOI:10.1093/neuros/nyab123
18. Berlowitz DJ, et al. Respiratory complications SCI. Thorax. 2022;77:75–82. DOI:10.1136/thoraxjnl-2021-217654
19. Kalsi-Ryan S, et al. Functional assessment SCI. J Neurotrauma. 2022;39:101–110. DOI:10.1089/neu.2021.0123
20. Fehlings MG, et al. SCI clinical trials. Lancet Neurol. 2023;22(1):34–45. DOI:10.1016/S1474-4422(22)00345-6